TYPE UM-771 AND UM-775

REFLECTOSCOPES®

OPERATING & MAINTENANCE

MANUAL NO. 50R075

Sperry®

AUTOMATION INDUSTRIES, INC.

SPERRY DIVISION

DANBURY, CONN., U. S. A.

CONTRACT NO. N00600-70-C-0204

TYPE UM-771 AND UM-775 REFLECTOSCOPES®

OPERATING & MAINTENANCE MANUAL NO. 50R075

MODEL NO... 50R075
SERIAL NO.. 1767-0
BOOK..... 1 of 3

AUTOMATION INDUSTRIES, INC.
SPERRY DIVISION
DANBURY, CONN., U. S. A.

February 1970

Digitized by the Internet Archive
in 2025

https://archive.org/details/manualsplus_09714

WARRANTY

A STANDARD WARRANTY ON EQUIPMENT OF SPERRY MANUFACTURE AGAINST DEFECTS IN MATERIAL AND WORKMANSHIP UNDER NORMAL USE AND SERVICE, WILL APPLY FOR A PERIOD OF ONE YEAR FROM DATE OF SALE. SPERRY WILL REPAIR OR FURNISH WITHOUT CHARGE, F.O.B. SPERRY'S PLANT, A SIMILAR PART TO REPLACE ANY PART OF SPERRY'S EQUIPMENT WHICH IS PROVEN TO HAVE BEEN DEFECTIVE AT THE TIME IT WAS SHIPPED. TUBE WARRANTY WILL BE EXTENDED ON THE SAME BASIS AS THE TUBE MANUFACTURERS' WARRANTY TO SPERRY. SPERRY SHALL IN NO EVENT BE HELD LIABLE FOR DAMAGES OR DELAYS CAUSED BY DEFECTIVE MATERIAL. SPERRY WILL MAKE NO ALLOWANCE FOR REPAIRS OR ALTERATIONS UNLESS MADE WITH SPERRY'S WRITTEN APPROVAL. WARRANTY DOES NOT APPLY TO CRYSTALS. SPERRY SHALL NOT BE LIABLE FOR FAILURE OF THE EQUIPMENT OR ITS OPERATORS TO DISCOVER DEFECTS.

REFLECTOSCOPE DISPLAY UNIT UM-771/775

TABLE OF CONTENTS

CHAPTER 1	INTRODUCTION	PAGE NO.
1.1	PURPOSE	1-1
1.2	SCOPE	1-1
1.3	DESCRIPTION OF THE EQUIPMENT	1-1
1.4	SPECIFICATIONS	1-4
1.5	ACCESSORY	1-8
CHAPTER 2	PREPARATION FOR USE	
2.1	GENERAL	2-1
2.2	UNPACKING AND HANDLING	2-1
2.3	PREPARATION FOR USE	2-1
2.4	ELECTRICAL INTERCONNECTIONS	2-2
CHAPTER 3	OPERATION	
3.1	GENERAL	3-1
3.2	CONTROL CONNECTORS AND INDICATORS	3-2
3.3	OPERATION	3-5
CHAPTER 4	ELECTRICAL DESCRIPTION	
4.1	GENERAL	4-1
4.2	THEORY OF OPERATION -GENERAL	4-1
4.3	THEORY OF OPERATION - DETAILED	4-4
CHAPTER 5	MAINTENANCE	
5.1	GENERAL	5-1
5.2	PREVENTIVE MAINTENANCE	5-1
5.3	CHECKOUT, ADJUSTMENT AND CALIBRATION	5-3
5.4	TROUBLESHOOTING	5-9
APPENDIX A	GLOSSARY	A-1
APPENDIX B	PRINCIPLES OF ULTRASONIC INSPECTION	
B1.0	INTRODUCTION	B-1
B1.1	BASIC CONCEPTS	B-1
B2.0	BASIC TESTING METHODS	B-14

TABLE OF CONTENTS (Cont'd)

APPENDIX C	PARTS LIST	PAGE NO.
C1.0	INTRODUCTION	C-1
C2.0	ORDERING INFORMATION	C-3
C3.0	TABLE OF BOARD NUMBERS	C-3
C4.0	PARTS LIST	C-4
APPENDIX D	SCHEMATIC	
D1.0	INTRODUCTION	D-1
	SCHEMATIC DIAGRAM UM -771/775 No. 50E618	

LIST OF ILLUSTRATIONS

Figure No.	Title	Page No.
	CHAPTER 1	
1-1	UM-775 Ultrasonic Reflectoscope	
1-2	UM-775 Reflectoscope CRT Display.....	1-3
1-3	UM-771/775 Reflectoscope CRT Screen.....	1-5
1-4	A Typical Pulser/Receiver 10S db.....	1-8
1-5	Pulser/Receiver HFN Series.....	1-10
1-6	Illustrates one of the many Search Units.....	1-11
	CHAPTER 3	
3-1	UM-771/775 Display Front Panel Controls.....	3-1
3-2	Block Diagram of the Timer/Display UM-771/775 Reflectoscope.....	3-3
3-3	Test Block 50A099 and CRT Waveform.....	3-9
3-4	Various Reject CRT Waveform.....	3-10
3-5	Back Reflection CRT Waveform.....	3-11
3-6	Initial Pulse and 1st Back Reflection.....	3-12
3-7	Initial Pulse, Hole and 1st Back Reflection..	3-12
3-8	Position of Test Block.....	3-12
3-9	CRT Waveform When Sweep Delay Controls Increased.....	3-13
3-10	Various CRT Hole Reflections.....	3-13
3-11	Various CRT Hole Reflections.....	3-13
3-12	Angle Beam Search Unit Placed On Standard Test Block.....	3-16
3-13	Path of Angle Sound Beam Through The Test Block. No Reflection From Holes.....	3-16
3-14	Beam Reflected From Middle Hole and From Corner of Test Block.....	3-19
3-15	Increased Return From Middle Hole and decreased Return from Corner Results In a Pattern as above.....	3-19
3-16	Reflection From Small Left Hand Hole.....	3-19
3-17	Reflection From Large Hole at Lower Right....	3-19
3-18	No Reflections Are Obtained When the Searching Unit is in the Position Shown Above.....	3-19
3-19	Aluminum Block with Saw Cut Notch.....	3-19
3-20	Cable Connections for Two Crystal (Thru-Transmission) Testing.....	3-20
3-21	Thru Transmission - Position A.....	3-21
3-22	Thru Transmission - Position B.....	3-22
3-23	Thru Transmission - Position C.....	3-22

(Continued)

Figure No.	Title	Page No.
	CHAPTER 3	
3-24	Arrangement of Accessory Equipment for Single Search Unit Operation.....	3-23
3-25	Positioning Search Unit for Maximum Penetration.....	3-25
3-26	Sound Path Through Water and Test Block.....	3-26
3-27	Signal Identification.....	3-26
3-28	Elimination of Initial Pulse and Water Path from CRT Screen.....	3-27
3-29	Use of Sweep Delay Position Interface Signal at Start of CRT Display.....	3-28
3-30	S.U. Positioning Fixture.....	3-29
3-31	Aluminum Block.....	3-29
3-32	Arrangement of Accessory Equipment for Through Transmission.....	3-30
3-33	Received Signals From Correctly Aligned Search Units.....	3-31
3-34	Received CRT Waveform.....	3-32
3-35	Received CRT Waveform.....	3-32
	CHAPTER 4	
4-1	Block Diagram of the +300VDC Regulation Circuit	4-3
4-2	Simplified Block Diagram of the ±12VDC Power Supply Circuit	4-5
4-3	Block Diagram of the High Voltage Power Supply and Unblanking Circuit.....	4-8
4-4	Unblanking Waveform at the Unput E2 of the High Voltage Board.....	4-9
4-5	Schematic of the CRT Circuit.....	4-10
4-6	Block Diagram of the Horizontal Amplifier Circuit.....	4-13
4-7	Block Diagram of the Vertical Amplifier Circuit.....	4-15
4-8	Various Waveforms, Pulse, Sync, Vert, Display, Video and DAC.....	4-16

Figure No.	Title	Page No.
	CHAPTER 5	
5-1	The UM-775 is illustrated with the covers removed.....	5-20
5-2	Various Components and Test Points in the. Low Voltage Power Supply Board Ass'y 50D568	5-21
5-3	Various Components in the High Voltage Power Supply and Unblanking Board Ass'y 50D575...	5-22
5-4	Various Components and Test Points in the . Deflection Amplifier Board Ass'y 50D569 ...	5-23
5-5	Various Components and Test Points in the . Interconnect Board Ass'y 50C1370.....	5-24
	APPENDIX B	
B-1	Principles of Ultrasonic Inspection.....	B-1
B-2	Generation of Ultrasonic Vibrations.....	B-2
B-3	Typical Search Unit.....	B-3
B-4	Reflection of the Ultrasonic Beam.....	B-4
B-5	Refraction of the Ultrasonic Beam.....	B-5
B-6	Longitudinal Waves.....	B-6
B-7	Angle Beam Search Unit.....	B-6
B-8	Generating Shear Waves In Metals.....	B-6
B-9	Shear Waves.....	B-7
B-10	Generating Surface Waves.....	B-7
B-11	Surface Waves.....	B-7
B-12	Particle Motion.....	B-8
B-13	Diagram of Typical Ultrasonic Flaw Detector	B-9
B-14	Conventional Inspection Method.....	B-16
B-15	Multiple Back Reflections.....	B-17
B-16	Various Back Reflections.....	B-18
B-17	Angle Beam Inspection Method.....	B-19
B-18	Through Transmission Method of Inspection..	B-20
B-19	Type 1, Display Interpretation.....	B-20
B-20	Type 2, Display Interpretation.....	B-21
B-21	Type 3, Dispaly Interpretation.....	B-22
B-22	Type 4, Display Interpretation.....	B-23
B-23	Type 5, Display Interpretation.....	B-24
B-24	Type 6, Display Interpretation.....	B-25
B-25	Type 7, Display Interpretation.....	B-26
B-26	Type 8, Display Interpretation.....	B-27
B-27	Type 9, Display Interpretation.....	B-28
B-28	Type 10, Display Interpretation.....	B-29

LIST OF ILLUSTRATIONS (Cont'd)

Figure No.	Title	Page No.
	APPENDIX C	
C-1	Transformer Chassis (T101).....	C-15
C-2	High Voltage And Plug-In Board Assembly 50C1372.....	C-17

LIST OF TABLES

Table No.	Title	Page No.
	Chapter 1	
1-1	UM Pulser/Receiver Types.....	1-9
1-2	HFN Pulser/Receiver Plug-in.....	1-10
	Chapter 2	
2-1	Fuse Values for 115V and 230V Line.....	2-2
	Chapter 4	
4-1	Low Voltage Power Supply Fuse List.....	4-2
	Chapter 5	
5-1	Summary of the Low Voltage Power Supply....	5-5
5-2	Horizontal and Vertical Amplifier Inputs...	5-8
	APPENDIX B	
B-1	Dimensions and Identification of Reference Blocks in the Basic ASTM Set.....	B-12
B-2	Dimensions and Identification of Reference Blocks in the Basic ASTM Set.....	B-12
B-3	Application Frequencies.....	B-13
	APPENDIX C	
C-1	Text Abbreviations and Reference Designators	C-1
C-2	P.C. Board Assemblies.....	C-3

(Continued)

LIST OF TABLES (Cont'd)

Table No.	Title	Page No.
	APPENDIX C	
C-3	Assembly Parts Breakdown.....	C-4
C-4	Parts Breakdown List.....	C-5
	Interconnect Board Assembly 50C1370.....	C-5
	Low Voltage Power Supply P.C. Board Assembly 50D568.....	C-5
	Deflection Amp. P.C. Board Assembly 50D569	C-9
	High Voltage P.C. Board Assembly 50D573...	C-12
C-5	Transformer Chassis Assembly 50C1355.....	C-15
C-6	High Voltage and Plug-In Board Assembly 50C1372.....	C-16
C-7	Rear Panel and L.V. Power Supply Assembly 50E615.....	C-18
	APPENDIX D	
D-1	Schematic Symbols Identification.....	D-2

LIST OF CHARTS

Chart No.	Title	Page No.
	TROUBLESHOOTING CHARTS	
5-1	No Spot or Sweep on CRT.....	5-12
5-2	Sweep Cannot Be Focused.....	5-13
5-3	Sweep Too Dim.....	5-13
5-4	Low or No +300 Volts.....	5-14
5-5	Low or No +150 Volts.....	5-14
5-6	Low or No -108 Volts.....	5-15
5-7	Low or No +75 Volts.....	5-15
5-8	Low or No +12 V (No Adjust).....	5-16
5-9	Low or No -12 V (No Adjust).....	5-16
5-10	No +4100V or -1580V.....	5-16
5-11	Vertical Line or Half the Horizontal Deflection on CRT.....	5-17
5-12	Horizontal Line or Half the Vertical Deflection on CRT.....	5-17
5-13	Low Voltage Power Supply Board No. 50D568..	5-18
5-14	High Voltage and Deflection Amplifier Board	5-19

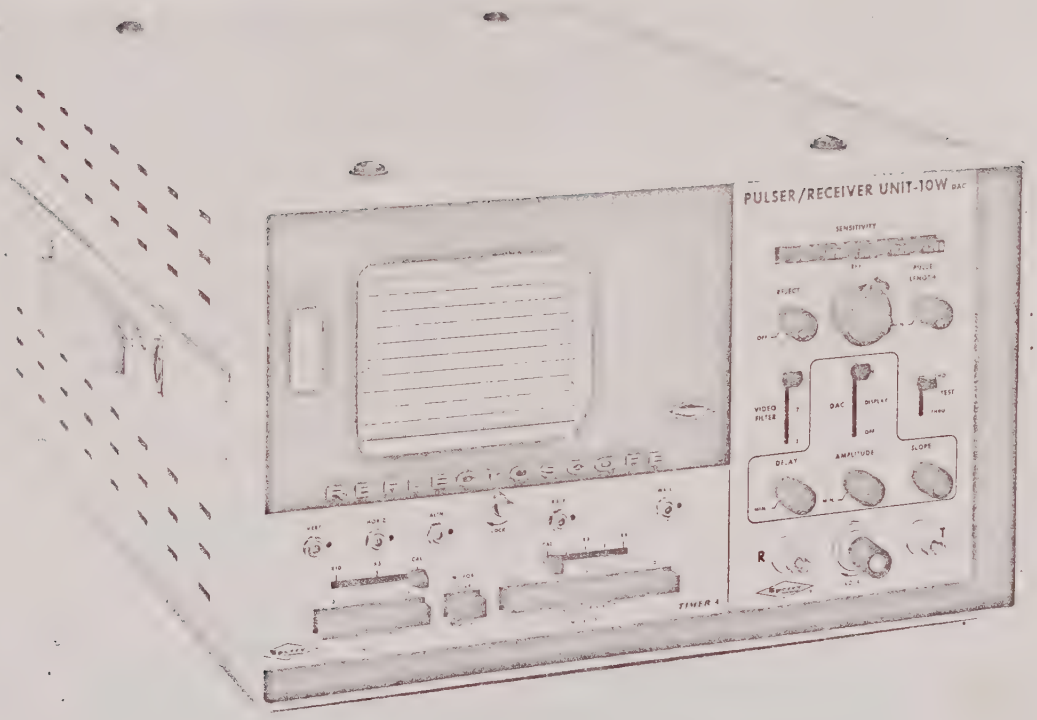


Figure 1-1 UM-775 Ultrasonic Reflectoscope

CHAPTER 1

INTRODUCTION

1.1 PURPOSE

The UM-775 Reflectoscope units, as illustrated in Figure 1-1, provides an ultrasonic nondestructive testing instrument which has been human engineered and designed for use as a bench laboratory Reflectoscope for ultrasonic testing applications.

1.2 SCOPE

This publication contains a general description, preparation for use, operation, electrical description, and maintenance on the UM-771 and UM-775 Reflectoscope. Supplemental data such as Glossary, Principles of Reflectoscope Operation, Parts List, and Schematic are included in the appendices at the rear of the manual.

1.3 INTRODUCTION AND GENERAL EQUIPMENT DESCRIPTION

1.3.1 The UM-771 and UM-775 Reflectoscopes are instruments used for ultrasonic nondestructive testing of materials. Ultrasonic inspection is generally applied to three classes of material inspection:

a. Locating internal discontinuities or inhomogeneities in materials.

b. Determining the differences in structure and physical properties.

c. Measuring the thickness of material.

The UM Reflectoscopes are visually interpreted ultrasonic instruments for both contact and immersion testing with either single or dual search unit techniques. Alarm and recording systems for ultrasonic inspection may be added for monitoring tests at production speeds.

1.3.2 General Description of the Equipment

Cabinet and chassis description: The UM-775 Reflectoscope cabinet is illustrated in Figure 1-1.

Two different types of chassis frames are available which will fit into two different sizes of wraparound, aluminum covers.

The CRT, Deflection Amplifier, Low Voltage and High Voltage Power Supplies are contained in the UM-771 and UM-775 Display Chassis. To complete the instrument, Timer and Pulser/Receiver Plug-in units are used in the UM-775 Reflectoscope. This arrangement constitutes a "basic" ultrasonic test instrument.

The UM-775 Reflectoscope is intended for use where interpretation is visual and no accessory functions are required, or planned for the future. Small size and weight are desirable features of the UM-775 Reflectoscope.

The UM-771 Reflectoscope is intended for use where more versatility in ultrasonic testing is required. Provision is made within the chassis for plugging in one accessory unit. The particular accessory unit may be selected to complement the Display/Timer and Pulser/Receiver units to perform specific ultrasonic tests such as Transigate for flaw detection or thickness readout for thickness measurement. The performance of the UM-771 and UM-775 are identical in the basic instrument version. The same quality and accuracy of tests will be obtained by using either the UM-771 or the UM-775 Reflectoscope. Various plug-in units of the UM-775 Reflectoscope are shown in Figure 1-2.

1.3.2.1 Display Circuitry

The display circuitry in the UM-771/775 Reflectoscope contains separate assemblies which are easily removed from the Reflectoscope chassis. The assemblies are:

a. Transformer chassis assembly.

b. Rear Panel and L. V. Power Supply Assembly (This includes heat sink, connectors, rear panel, wire harness, and Low Voltage P.C. Board).

c. High Voltage and Plug-in Board Assembly (This includes wire harness to CRT and High Voltage Power Supply).

d. Deflection Plug-in Board Assembly (This includes wire harness and Deflection P.C. Board assembly).

e. Interconnect Board Assembly (This includes connector, wire harness, and Interconnect Board sub-assembly).

Figure 1-2 UM-775 Reflectoscope CRT Display with Timer and Pulser/Receiver Plug-in Units

1.3.2.2 The Cathode Ray Tube

The cathode ray tube is a five-inch diameter, flat-faced type with a 3 inch x 4 inch display area. Graticule scribed lines are permanently etched on the inside of the CRT. All operating controls for the display are located on the front panel, and functionally grouped for ease of operation.

1.4 SPECIFICATIONS

1.4.1 Mechanical Specifications

1.4.1.1 The instrument frame is made up of self-supporting clear anodized aluminum members and is covered with removable painted aluminum covers.

1.4.1.2 A carrying case handle is used for easier instrument portability.

1.4.1.3 Foot-knobs at the four corners, bottom, and rear of the instrument permits positioning in either upright or horizontal positions.

1.4.1.4 Fuses, and power connections, are located in the recessed instrument back. ON/OFF power instrument indicator light and front controls are located in the front recessed instrument front. Ventilation fan provides filtered, pressurized forced air ventilation, assuring proper operating temperature for all components in the Display, the Timer, Pulser/Receiver and the Accessory Unit.

1.4.1.5 A rectangular, 3 x 4 inch high-intensity viewing screen has scribed graticule on the inside face of the cathode ray tube. Since the graticule reference lines are etched on the inside face of the CRT tube glass, parallax waveform errors are kept at a minimum. An outline of the actual size CRT screen is illustrated in Figure 1-3.

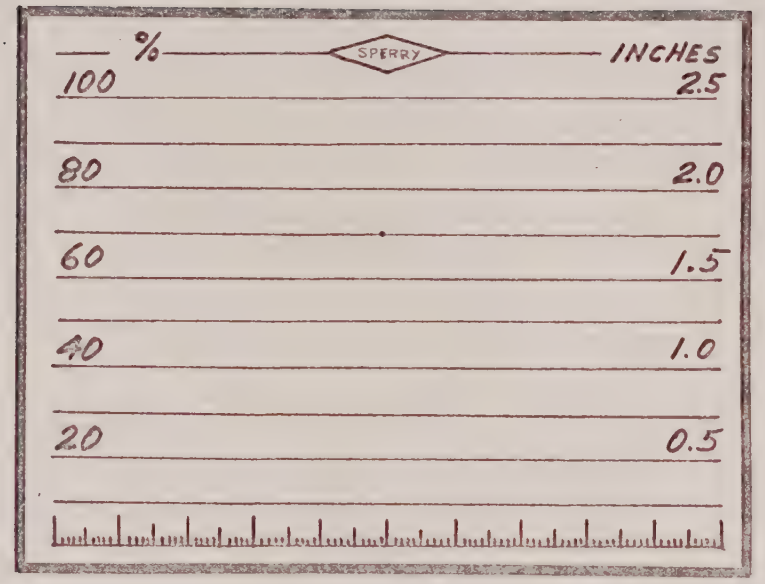


Figure 1-3 UM-771/775 Reflectoscope CRT Screen (Actual Size)

1.4.1.6 Weight of the UM-771/775 Reflectoscope

UM-771 Reflectoscope		UM-775 Reflectoscope	
CRT Display	30 lbs	CRT Display	26 lbs
Timer Plug-in Unit	2.5 lbs	Timer Plug-in Unit	2.5 lbs
Pulser/Receiver Plug-in Unit	2.5 lbs	Pulser/Receiver Plug-in Unit	2.5 lbs
Accessory Plug-in Unit	3 lbs		
Total Weight	38 lbs	Total Weight	31 lbs

1.4.1.7 Size of the UM-771 and UM-775 Reflectoscope CRT Display

UM-771 Reflectoscope		UM-775 Reflectoscope	
Height	7-3/8 inches	Height	7-3/8 inches
Width	19-3/4 inches	Width	13-1/8 inches
Length	20-1/4 inches	Length	20-1/4 inches

1.4.1.8 Plug-in Modules

a. The Pulser/Receiver plug-in unit slides in and out on plastic-aluminum channel frame members and is locked in position by a knob control cam.

b. The Accessory Plug-in unit slides in and out on plastic-aluminum channel frame members and is locked in position by a knob control cam.

c. The Timer plug-in unit slides in and out on plastic-aluminum channel frame members and is locked in position by a knob control cam.

1.4.2 Electrical Specifications

UM-771/775 Reflectoscope CRT Display

1.4.2.1 Power Requirements

a. UM-771 Reflectoscope (with plug-in units) 115V plus or minus 15V or 230 plus or minus 30V, single phase 50 to 60 cycles, 132 watts.

b. UM-775 Reflectoscope (with plug-in unit) 115V plus or minus 15V or 230 plus or minus 30V, single phase 50 to 60 cycles, 132 watts.

1.4.2.2 Operating Temperature Range ---- -28.9°C to 71.91oC (-20°F to 160°F).

a. Transformer chassis assembly - provides AC input power supply voltages. Also provides CRT-AC filament voltage.

b. Rear Panel and L.V. Power Supply Assembly - this circuit furnishes the voltages needed to operate high voltage supply, deflection amplifiers, interconnect board, cathode ray tube, the Pulser/Receiver and Timer.

c. High Voltage and Plug-in Board Assembly - this circuit supplies high voltage to the CRT. This board also contains the unblanking amplifier.

d. Deflection Plug-in Board Assembly - contains five major circuits:

   1. Horizontal deflection amplifier.

   2. Vertical selection circuit (This circuit is for time sharing the vertical information).

   3. Vertical deflection amplifier.

   4. Vertical mixing network.

   5. CRT trace alignment control.

e. Interconnect Board Assembly - the function of this board is a terminal device through which five of the major assembly interconnections are made:

   1. Low Voltage Power Supply.

   2. High Voltage Power Supply.

   3. Deflection Amplifier and Timer.

   4. Pulser/Receiver.

   5. Accessory.

f. Cathode Ray Tube - the vertical CRT indications of the initial pulse delivered to the search unit and all echo signals received by the search unit are displayed on the CRT horizontal base line.

1.5 ACCESSORIES

Addition of any standard UM accessory without modification is possible by merely plugging into accessory space. Such standard accessories are listed below.

a. Pulser/Receivers and Search Units.

b. Special Function Cabinet.

c. Front Plug-in Units.

d. Rear Plug-in Units.

e. Timer-A.

1.5.1 Pulser/Receivers and Search Units

Sperry Pulser/Receiver plug-in modules are available in frequencies from 200KHz to 50 MHz (partial list in Table 1-2) for operation with UM-771/775 Reflectoscope Display Units (see Figure 1-4). They contain the circuitry for generation and transmission of high frequency pluses to the transducer, for receiving, amplifying, and detecting the high frequency echo or return pulses from the test specimen, and for limiting and transferring the detected video pulses to the time control unit and thence to the Reflectoscope Display and any accessory equipment in use.

Figure 1-4 A Typical Pulser/Receiver 10S db

TABLE 1-1

UM PULSER/RECEIVER TYPES

Ass'y No.	Type	Frequencies	Description
50E534	1N	0.2, 0.4, 1.0 MHz	Similar to 5N, different frequency range.
50E528	2.25N	0.4, 1.0, 2.25 MHz	Similar to 5N, different frequency range.
50E524	5N	1.0, 2.25, 5.0 MHz	General purpose Pulser/ Receiver.
50E597	5NUR	1.0, 2.25, 5.0 MHz	5N Modified to Match UR Scope.
50E542	5N-RF	1.0, 2.25, 5.0 MHz	5N With RF Display.
50E584	5N-Weld	1.0, 2.25, 5.0 MHz	Weld Inspection.
50E533	10N	2.25, 5.0, 10.0 MHz	General Purpose.
50D566	10S	1.0, 2.25, 5.0, 10.0 MHz	General Purpose Solid State.
50D525	10S db	1.0, 2.25, 5.0, 10.0 MHz	General Purpose DB controls Solid State.
50D558	10W	500 KHz to 10 MHz	Solid State
50D571	10W DAC	500 KHz to 10 MHz	Solid State with Distance Amplitude Correction
50E577	50W	10.0 to 50 MHz	High Resolution Broadband P/R for thickness measurement.

1.5.1.1 HFN Pulser/Receiver Plug-in (See Figure 1-5).

Flexible design permits optimum performance at selected frequencies by use of a separate plug-in printed circuit board for each frequency. High sensitivity and high resolution are obtained through the use of these pre-tuned plug-in boards.

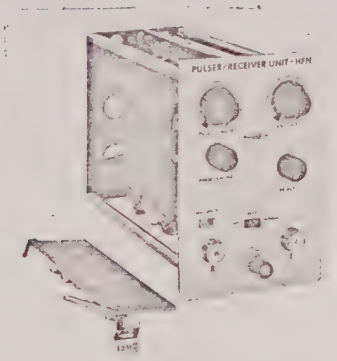


Figure 1-5 Pulser/ Receiver HFN Series

Table 1-3 contains information on types, frequencies and characteristics of the various plug-in UM Pulser/Receiver HFN Series.

TABLE 1-2

HFN Pulser/Receiver Plug-in

Ass'y No.	Frequencies	Description
50E527	HFN Pulser/Receiver (Less Freq. Boards)	
50K4187	HFN Bd. 200 KHz	
50K4188	HFN Bd. 400 KHz	
50K4256	HFN Bd. 1.0 MHz	Plug-in Frequency Boards
50K4257	HFN Bd. 2.25 MHz	are used for various
50K4249	HFN Bd. 5.0 MHz	High Resolution and
50B954	HFN Bd. 10.0 MHz	Sensitivity requirements
50B955	HFN Bd. 15.0 MHz	
50K4493	HFN Bd. 20.0 MHz	
50B956	HFN Bd. 25.0 MHz	
50K3923	HFN Bd. 45.0 MHz	

1.5.1.2 Search Units

A Search Unit is a piezoelectric transducer specifically designed for ultrasonic inspection. Automation Industries manufactures a complete line of search units including single and dual element contact, angle beam, immersion and water delay line combinations.

Typical crystal materials used in the construction of these devices are lithium sulphate, barium titanate, lead zirconate titanate and quartz. These materials are used both singularily or in combination in order to obtain the optimum results from their respective piezoelectric properties.

Figure 1-6 Illustrates one of the many Search Units

Immersion search units are available in flat and focused configurations. Contact testing search units are offered with flat elements for direct application to the material under test. Various adaptors such as abrasion resistant wear faces, liquid and solid delay lines as well as beam refracting wedges for angle beam inspection are available. A wide variety of element sizes, connector designs and case styles afford an excellent selection for all inspection requirements.

1.5.2 Type UM-710 Special Function Cabinet

1.5.2.1 The Type UM-710 Special Function Cabinet is designed to house plug-in accessory components which will increase the versatility and range of applications of the basic UM Reflectoscopes by providing a wide variety of special functions for recording, gating, controlling, counting, and alarm purposes.

1.5.2.2 The Special Function Cabinet is designed to mount either beneath or above Type UM Reflectoscopes. Additional cabinets may be added as required to increase special function capabilities by providing for the use of more plug-in components. The Special Function Cabinet is the same size as the Type UM Reflectoscope.

1.5.2.3 Many different configurations are possible when the Special Function Cabinet is combined with a Type UM Reflectoscope. Gating units may be combined with recording units, additional Pulser/Receiver units may be combined with gating units to greatly increase the number of channels available.

1.5.3 Front Plug-in Units for the Reflectoscope UM-771 and/or Special Function Cabinet UM-710.

a. The Fast Transigate Ass'y No. 50C753. The Fast Transigate provides flexibility in establishing ultrasonic inspection systems for semi-automatic or automatic detection of flaws in materials at production speeds. This is accomplished by setting up specific, controllable gated areas or zones within a test piece. Signals appearing within these gates generate visual and/or aural alarms.

b. Dual Fast Transigate Ass'y No. 50E621. The Dual Fast Transigate is similar to the Fast Transigate Assembly except that this unit has Dual Fast Transigate characteristics.

c. TR Thickness Readout Module Ass'y No. 50E568. This unit is designed to provide an indication of thickness, using signals derived from any Pulser/Receiver unit. A feature of this module is the ability to provide an expanded scale readout, and an alarm at any selectable thickness. As little as 10% of full scale thickness can be presented, i.e., a 1" thickness could be set to read .95" at one end of the scale and 1.05" at the other end.

d. Attenumeter Ass'y No. 50E601. Measures attenuation of ultrasound energy in materials and provides direct meter readout in dB/inch through four ranges: 0-2, 0-5, 0-10, and 0-20. Plugs into UM Reflectoscope.

e. Type UM DAC - Distance Amplitude Correction - Ass'y No. 50E551. Capable of correcting signal response in "near field" zone and "far field" zone, with simultaneous display of both video signals and DAC curve for easy set-up.

f. Type UM Transigraph Control for shaded tone recording, Ass'y No. 50E543. Transigraph system plugs into UM-710 Special Function Cabinet and requires 50C753 Transigate and 50A3159 STF Recording Amplifier.

g. Graphigate for shaded tone recording, Ass'y No. 50E589. The Graphigate plugs into the extra compartment of the UM 771 Reflectoscope and is used with the 50K4755 Type "S" single panel Recording Amplifiers for shaded X-Y facsimile recordings.

h. SW Channel Selector, Ass'y No. 50D288. Display selector for multi-channel System.

1.5.4 Rear Plug-in Units for the UM-771 Reflectoscope and the Special Function Cabinet UM-710.

a. Type "Z" Transfer Chassis, Ass'y No. 50D275. Required for multi-channel systems with one or two Pulser/Receivers, the "Z" transfer chassis relays information between the Reflectoscope and other modules. It is a double panel module which plugs into the rear of the UM710 Special Function Cabinet.

b. Type "R" Relay Chassis, Ass'y No. 50C434. The "R" Relay Chassis is a double panel plug-in module designed to fit into the rear of the UM710 Special Function Cabinet and to operate with one Pulser/Receiver. It accepts two front panel special function modules and provides outputs for driving external solenoids and alarms and for feeding signal information to external pre-amplifiers for recorders.

c. Type "RM" Relay Chassis, Ass'y No. 50C563. The "RM" Relay Chassis provides the same outputs as the "R" Chassis, but is used in multi-channel operation with more than one Pulser/Receiver.

d. Type "S" Recording Amplifier, Ass'y No. 50E530. A double panel plug-in designed to fit into a rear compartment of the UM710 Special Function Cabinet, the Type "S" Recording Amplifier operates with a single channel system (one Pulser/Receiver). The "S" Recording Amplifier accepts two front panel special function modules and provides outputs from information received from associated circuits.

The Type "S" yields outputs the same as those of the "R" Relay Chassis, and also provides outputs for direct operation of strip chart or wet facsimile (Alfax) recorders with no other amplifiers required.

e. Type "SM" Recording Amplifier, Ass'y No. 50B969. The "SM" Recording Amplifier is used for multi-channel operation with more than one Pulser/Receiver where outputs similar to the type "S" Recording Amplifiers are required.

f. Type "STF" Recording Amplifier, Ass'y No. 50A3159. The Type "STF" Recording Amplifier is a double panel rear compartment plug-in for wet type shaded tones x-y facsimile recordings. It is designed to accept one Transigate module and one Transigraph module.

g. Type "RS" Recording Amplifier, Ass'y No. 50K4745. A double panel rear plug-in, this module is designed to operate with one Pulser/Receiver. It accepts two front panel Special Function modules and provides outputs received from associated circuits for driving external solenoids and alarms and to feed signals into strip chart and wet or dry x-y facsimile recorders (black and white, no shaded tones).

h. Type "RSM" Recording Amplifier, Ass'y No. 50K4756. This double panel plug-in provides the same outputs as the Type "RS" but is used in multi-channel operation with more than one Pulser/Receiver.

i. Type "R-STF" Recording Amplifier, Ass'y No. 50K4741. The "R-STF" Recording Amplifier is a double panel rear plug-in used for shaded tones x-y wet or dry facsimile recordings. It accepts one Transigraph module and one Transigate module.

j. Type "S" Single Panel Recording Amplifier, Ass'y No. 50K4654. This rear plug-in module fits into the UM-771 Reflectoscope and is used with a Transigate module for wet or dry x-y facsimile recordings (black and white, no shaded tones).

k. Type "S" Single Panel Recording Amplifier, Ass'y No. 50K4755. The Type "S" Single Panel Recording Amplifier plugs into the rear of the UM-771 Reflectoscope for wet or dry shaded tone x-y facsimile recordings when used with Style 50E589 Graphigate. When used with a Transigate module, wet or dry black and white x-y recordings may be made.

1.5.5 Timer-A. Timer Plug-in Unit is used with the UM-771 and UM-775 Reflectoscope. The Timer Unit plugs into the lower left side of the Reflectoscope.

1.5.5.1 Timer-A Specification

a. Sweep range - continues from 0 too 500 inches of material.

b. Material - adjusts sweep range calibration for various materials from Teflon thru aluminum.

c. Sweep delay - continues control from 0 to 200 inches in steel.

d. Rate (Pulse) - 100 to 2,000 Hz (pps) a lockout feature is provided to step down the repetition rate for long sweep delay and sweep times, thus allowing maximum brightness for all testing conditions.

e. Mode-Longitudinal or Shear wave, sweep calibration. Shear wave calibrated in steel (1.8:1).

f. Sweep linarity ± 1%.

g. Alternate trace - provides alternate display (DAC).

CHAPTER 2

PREPARATION FOR USE

2.1 GENERAL

This chapter contains unpacking, handling, installation and initial instrument check out. The following steps should be followed to assure optimum operating conditions.

2.2 UNPACKING AND HANDLING

2.2.1 The UM-771/775 Reflectoscope is secured in a shock absorbent molded rubberized hair nest material and packed into a cardboard box for shipment. Also packed in the nest is an accessory kit.

2.2.2 To Remove Reflectoscope, Proceed as Follows:

a. Open the cardboard shipping container by cutting the tape which seals the two half flaps together to the sides of the container.

b. Lift off the top cover of the rubberized hair nest. The Reflectoscope, the accessory kit, and the instruction manual should be visible.

c. Remove the accessory kit and instruction manual. It is suggested that the Instruction Manual be read several times by the novice Reflectoscope operator to familiarize himself with the capabilities of the instrument.

d. Carefully, and with two hands, remove the Reflectoscope from the carton and visually inspect it for any signs of damage such as dents or scratches. If any damage is found, immediately contact the carrier and the area representative for Automation Industries, Inc., Sperry Division. Do not destroy the shipping container until a satisfactory inspection has been completed. It is suggested that the shipping container be retained and stored in a suitable location.

2.3 INSTALLATION

Installation of the unit is accomplished by placing the Instrument in a desired location. A firm base is suggested to minimize the chance of the unit falling. It is also suggested that the unit be placed in a tilted face up position for easier and precise instrument waveform viewing.

2.4 ELECTRICAL INTERCONNECTIONS

Application of AC power to the UM-771/775 Reflectoscope.

2.4.1 The UM-771/775 Reflectoscope Unit will be shipped in a 115 VAC input power source configuration, unless otherwise specified.

CAUTION

The Proper operating line frequency should be between 50 and 60 Hz. Operating the instrument below 50 Hz or above 60 Hz could cause severe damage to to the instrument. Blower motor will not operate at those frequencies and could cause instrument components to overheat.

2.4.2 Connect the input power source, 115 VAC, 60 Hz to the three prong connector J107 at the rear of the unit. If 230 VAC input power source is to be used, refer to Paragraph 2.4.2.1.

2.4.2.1 The following steps should be followed in changing the UM-771/775 Reflectoscope input power source from 115 VAC to 230 VAC.

TABLE 2-1

Fuse Values for 115V and 230V Line		
Line Voltage	UM-771	UM-775
115 V	5 AMP*	2.5 AMP*
230 V	2.5 AMP*	1.25 AMP*

* Slow Blow

CAUTION

With the Reflectoscope in the OFF position, the input power source, 115 VAC, is present at J107 and J108. Always disconnect 115 VAC power cord before any maintenance or modification is performed on the unit.

a. Disconnect Jumper wire Pin 8 and 16 of P104 and reconnect jumper wire to Pin 8 and 12 at P104.

b. Disconnect AC wire connections at J108. Do not disconnect ground wire at J108.

c. Disconnect Jumper wire Pin 4 and 12 of P104 and connect Pin 4 of P104 to the one side of J08.

d. Connect the other side of J108 to Pin 12 of P104.

e. Change F101 and F102 from 2.5 AMP to 1.25 AMP fuses.

f. Change voltage nameplate to the appropriate A.C. input voltage.

g. After completing the proceeding steps (a to f), the Reflectoscope is now ready to operate on 230 VAC, 50-60 input Hz power source.

2.5 Initial Reflectoscope Checkout.

2.5.1 Push ON/OFF button to energize the Reflectoscope. Button light should energize.

2.5.2 Check if the blower motor fan is energized and running smoothly. The direction of the air flow should be from the Outside - IN (pressurized).

NOTE

Do not obscure the air intake screen with loose paper, etc. This could cause air blockage and cause the Reflectoscope to overheat.

2.5.3 After approximately one minute, a sweep trace should appear on the CRT.

CAUTION

If the intensity is allowed at a high level of brightness for long periods, it is possible to permanently burn a line on the CRT tube.

2.5.4 Adjust astigmatism and focus for the sharpest trace if necessary.

2.5.5 Check if the Horizontal sweep line is positioned at the zero scribe line. Use the horizontal and the vertical controls to position the sweep line if necessary. The sweep line should be of equal brightness from left to right of the CRT. The sweep line should also be parallel to the zero scribe line.

2.5.6 The Reflectoscope should now be ready for use. To check the Reflectoscope operational control functions, refer to Chapter 3, Section 3.4.

CHAPTER 3

OPERATION

3.1 GENERAL

The purpose of this chapter is to give the operator the proper instructions for control and operation familiarization of the UM-771/775 Reflectoscope. It is recommended that the inexperienced operator thoroughly read and study this section prior to doing any ultrasonic testing. A brief introduction to the Principles of Ultrasonic Testing is located in Appendix B and is also suggested for the novice operator.

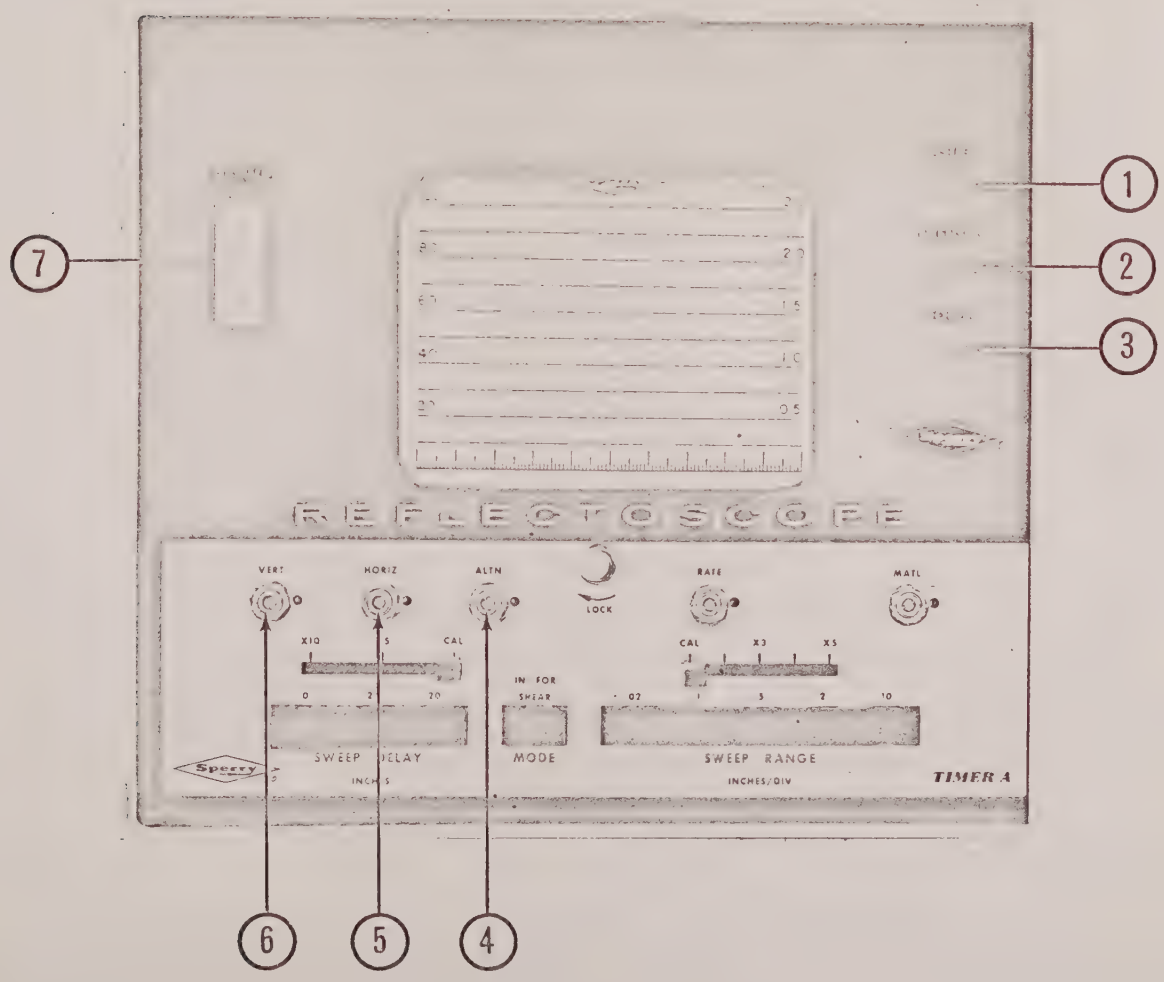


Figure 3-1 UM-771/775 Display Front Panel Controls

3.2 CONTROLS, CONNECTORS AND INDICATORS

The controls, connectors, and indicators herein are those for the UM-771/775 Reflectoscope display unit.

3.2.1 UM-771/775 Reflectoscope.

3.2.1.1. Control Groups (See figure 3-1)

The display contains the following front panel controls which are grouped into functional categories. The trace adjustments are located to the right of CRT and on the Timer unit. The ON/OFF button is located on the left of the CRT Bezel.

a. Trace Screwdriver Controls are:

(1) ASTIG.....CRT Astigmatism Control

(2) INT.....CRT Intensity Control

(3) FOCUS.....CRT Focus Control

(4) ALTN.....Alternate Control

(5) HORIZ.....Horizontal Centering Control

(6) VERT.....Vertical Centering Control

b. Miscellaneous Control

(7) Power - Main Power ON/OFF Switch

3.2.1.2 Trace Adjustment Controls (See Block Diagram Figure 3-2)

a. ASTIgmatism Control - The ASTIGMATISM Screwdriver Control is located right of the CRT and is used to correct for any Trace Astigmatism. In general, the INT, FOCUS, and ASTIG Controls should be alternately adjusted several times until the desired overall brightness and sharpness are obtained.

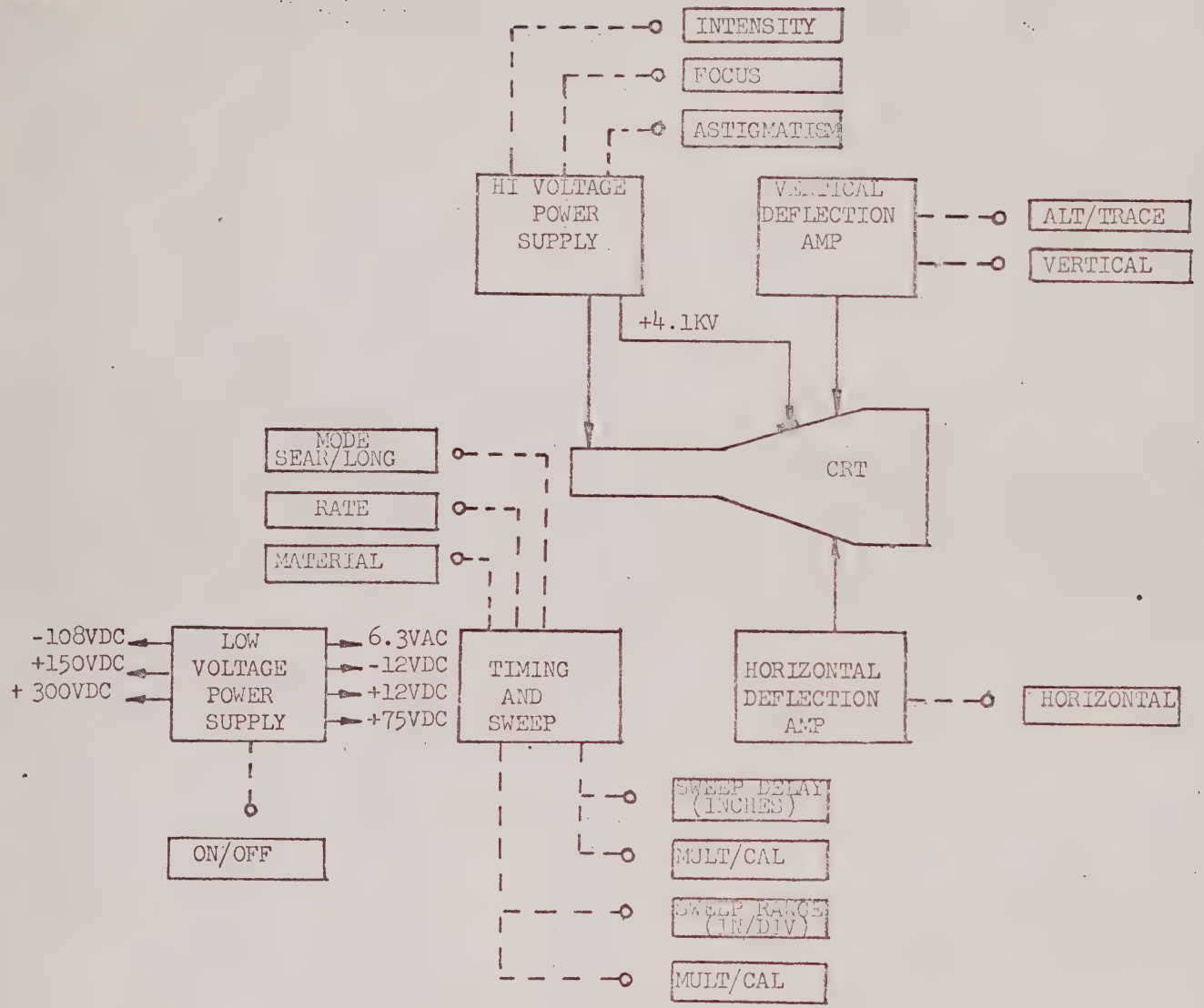


Figure 3-2 Block Diagram of the Timer/Display UM-771/775 Reflectoscope

b. INTensity Control - The INTENSITY Screwdriver Control is located on the right side of the CRT and is used to control the brightness of the trace on the cathode-ray tube display.

c. FOCUS Control - The FOCUS a Screwdriver Control is located under the INTENSITY Control and is used to adjust the sharpness of the trace. Changes in the INTENSITY Control will usually require a slight readjustment of the FOCUS Control.

d. ALTN. Control - The ALTERNATE (vertical) Screwdriver Control is located in the Timer unit. The Alternate Centering Control is used for positioning the Alternate CRT Trace vertically.

e. VERtical Centering Control - The vertical a screwdriver is located in the Timer unit. The VERTical Centering Control provides for positioning the CRT trace Vertically.

f. HORIZontal Centering Control - The Horiaontal a Screwdriver Control is located in the Timer unit. The HORIZontal Centering Control is used for positioning THE CRT TRACE HORIZONTALLY.

3.2.1.3 Miscellaneous Control

a. Power Switch is located to the left of the CRT. By pressing the ON/OFF White Power (button) switch the UM-771/775 Reflectoscope will energize or de-energize. The White Power Button will light when in the energized position.

3.2.1.4 Internal Controls

In general, internal controls seldom, if ever require adjustment, All internal controls are adjusted during final instrument.checkout and should only be adjusted during instrument maintenance line-up. (See Chapter 5)

3.3 OPERATION (FAMILIARZATION

3.3.1 Basic Training Procedure

The purpose of this section is to provide the new operator with a knowledge of the basic operating procedures Contact, Thru and Immersion testing techniques employed in ultrasonic testing with a Sperry UM-771/775 Reflectoscope. This section is not intended to be a complete instruction on Reflectoscope operation- its purpose is merely on familiariztion and training. Contact testing refer to section 3.3.3, Thru testing Section 3.3.6, and Immersion testing section 3.3.7.

Testing with the UM Reflectoscope is both rapid and simple. However, it does demand, on the part of the operator, a complete familiarity with the instrument, with testing techniques and with the physcial characteristics of the material being tested.

The new operator should follow the instructions given in this section the first time he uses the instrument. It is recommended that the procedures be run through several times thereafter, and that the operator experiment with various combination to further familiarize himself with the operating characteristics of the instrument.

NOTE

While specific procedures may vary in detail depending in the particular selections of plug-in componets, the instructions in this Section are designed to provide basic training for general UM Reflectoscope testing.

3.3.2 Setup Procedure

a. Preparation For Use

1. Assemble the following accessory equipment:

(a) Waste cloths and special multi purpose couplant. 5 Oz. tube. (Sperry Part No. 50A4085)

(b) Test block Sperry Style No. 50A099

(c) Search Unit (2.25 MHz) and Cable

2. Place Reflectoscope on work bench or other suitable location.

3. Check to assure that the Pulser/Receiver unit is securely plugged in and kurled locking knobs are turned finger tight.

4. Connect AC power cord to power plug J107 at the rear of Reflectoscope Cabinet.

5. Connect 3-prong AC power cord to input AC power supply (See Nameplate).

Make certain that the Reflectoscope is grounded. A grounding wire is provided in the 3-wire power cord but in some locations, additional grounding may be necessary.

3.3.3 Familiarization (Contact Testing)

The following procedures are outlined to give preliminary familiarization with UM Reflectoscope Componet controls:

a. Display Unit

(1) Set display controls at the following approximate positions:

(a) Power Switch - Push ON/OFF button to energize UM Reflectoscope.

(b) Intensity - Adjust for proper brightness.

CAUTION

If intensity is allowed at a high level of brightness for long periods, it is possible to permanently burn a line or spot on the CRT tube.

(c) Astigmatism and Focus - adjust for sharpest trace on both vertical and horizontal lines.

b. Timer Unit

1. Horizontal Positioning - set to place sweep start at left edge of the screen.

2. Vertical Positioning - adjust so that trace line appears on zero scribe line on bezel.

3. Sweep Range - Set range controls to Cal .1 position.

NOTE

CAL (calibrate) Vernier controls on Timer-A are equal to an exact multiplier factor of one (X1) in sweep range and sweep delay positions. When the Vernier control ranges are other then in the CAL position, the multiplier factor is only an approximation number.

4. Sweep Delay - Set sweep delay to 0 inches.

c. Pulser/Receiver Unit

1. Reject - minimum position (full counterclockwise).

2. Pulse Length - quarter turn from full coumterclockwise.

3. Connect one end of search cable to threaded connector marked R on front panel of Pulser/Receiver unit.

4. Connect other end of cable to a 2.25MHz straight beam search unit.

5. Test Mode - Normal or echo

6. Sensitivity - Mid-range

7. Frequency - Set to frequency of search unit.

3.3.4 Familiarization - Detail

With search unit over large hole as in Figure 3-3, use the Sensitivity control to vary the amplitude of indications and set control so that the back reflection appears approximately 2.3"high.

a. Pulser/Receiver

(1) Study the action of the Pulse Length control. Longer pulse for penetration, shorter pulse for resolution. Set Pulse Length control full CCW for shortest pulse.

(2) Study the action of the Reject control. Note that the indications are shortened as more reject is applied by turning control clockwise. Although the indications appear to be shortened as with Sensitivity control, note that the smallest indications disappear completely when enough reject is applied. Sensitivity reduces or increases the amplitude of all indications proportionately whereas reject is used to "clip" off the bottoms of indications to remove undesirable small signals. (Figure 3-4). Return Reject to OFF, full CCW and it should remain OFF during familiarization operations.

CAUTION

The Reject Control should be used with discretion. The operator should always bear in mind that even small indications may be important when interpreting test patterns of the CRT display. Use of reject destroys linearity of signal amplitude relationship, thereby making evaluation of defect size difficult or impossible.

d. Testing

Using Test Block (50A099), place a few drops of the multi purpose couplant on the long edge surface with large test hole away from the couplant surface. Place search unit on the couplant surface and note indications appearing on CRT. It may be necessary to change sensitivity so that first back reflection is 2-1/4 inches in height. Moving the search unit back and forth along the couplant surface, locate test holes on the scope, then by changing each of the controls, become familiar with the result of such adjustments. (Figure 3-3).

NOTE

All voltages are internally regulated to provide stable operation within voltage range from 105 - 125 volts. Should additional regulation be required, a Sola Constant Voltage Transformer, Sperry No. 50C383 (Sola 23-22-150) should be used.

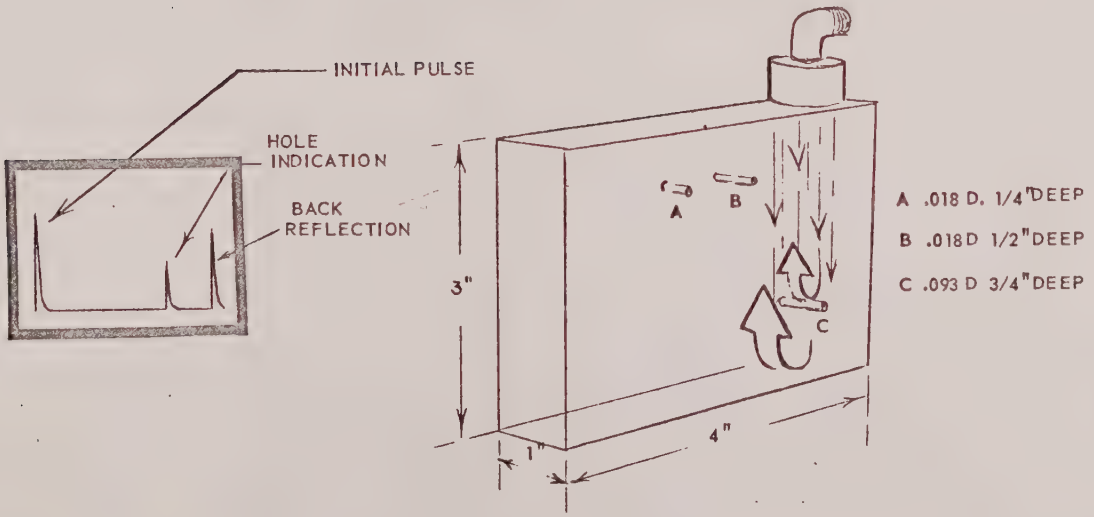
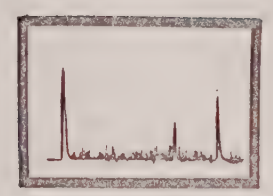
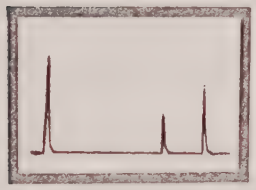


Figure 3-3 Test Block 50A099 and CRT Waveform



WITHOUT REJECT



WITH REJECT - SMALL BASE LINE SIGNALS HAVE BEEN CLIPPED OFF PRESENTING A CLEANER BASE LINE

Figure 3-4 Various Reject CRT Waveforms

b. Display/Timer Unit

(1) Place search unit on block so that only the Back Reflection shows. Increase sweep range and note that the Back Reflection moves to the left toward the Initial Pulse and that more indications appear moving in from the right side of screen. (Figure 3-5). Sound bounces off the bottom of the block and travels to the top of the block where a portion is transformed into electrical energy by the crystal, is amplified and displayed on the screen as the first Back Reflection. Some of the sound bounces back down to the bottom of the block and then again to the top and appears on the screen as the second Back Reflection. This bouncing between top and bottom surfaces is repeated until the sound is completely attenuated. All these bounces appear on the screen as multiples of the first back Reflection and are equally spaced on the trace. In other words, if the distance between top and bottom surfaces of

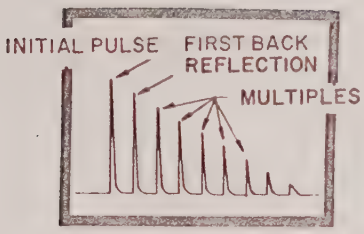


Figure 3-5 Back Reflection CRT Waveforms

the block is 3", then ten multiples of the Back Reflection will represent 30". The Sweep Range controls allow us to see more time, more material or deeper into the material.

2. Place search unit to a position on reference block at which only the back Reflection shows. Set Sweep range to CAL and .5 position. The leading edge of the Initial Pulse and the leading edge of the Back Reflection should appear as shown in figure 3-6.

NOTE

The waveform is deflected six divisions. One division equals 0.5 inches.

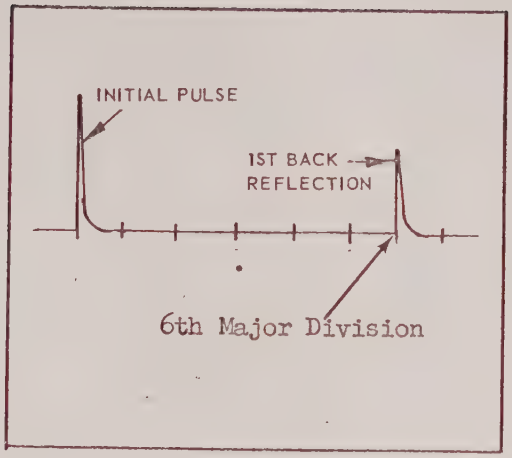


Figure 3-6 Initial Pulse and 1st Back Reflection

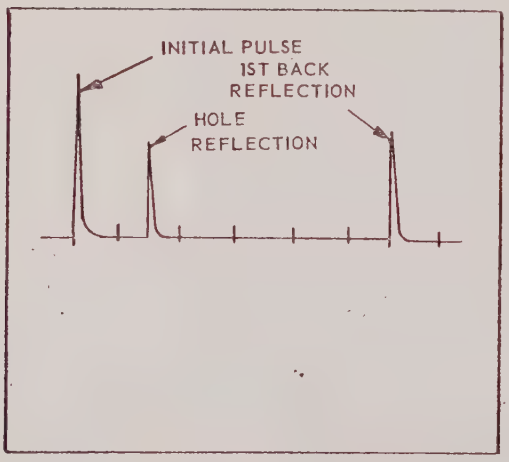


Figure 3-7 Initial Pulse, Hole and 1st Back Reflection

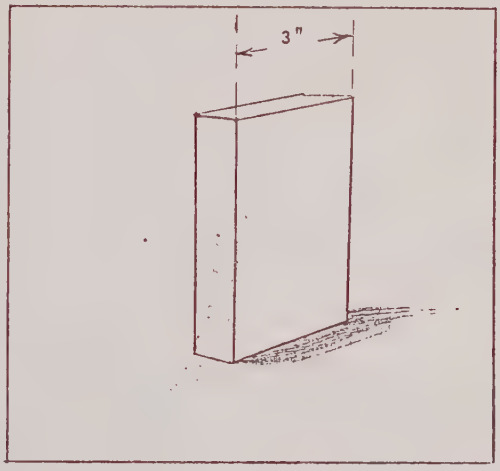


Figure 3-8 Position of Test Block

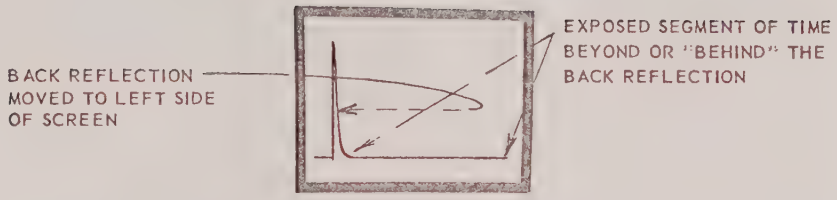


Figure 3-9 CRT Waveform When Sweep Delay Controls Increased

NOTE

It is important to become completely familiar with Sweep Delay and Sweep Length in order to understand what we see on the screen and to know what part of the test piece they represent. Sweep Delay permits you to "see" a portion of the material at a distance from the test surface. Sweep Length allows you to see more or less material.

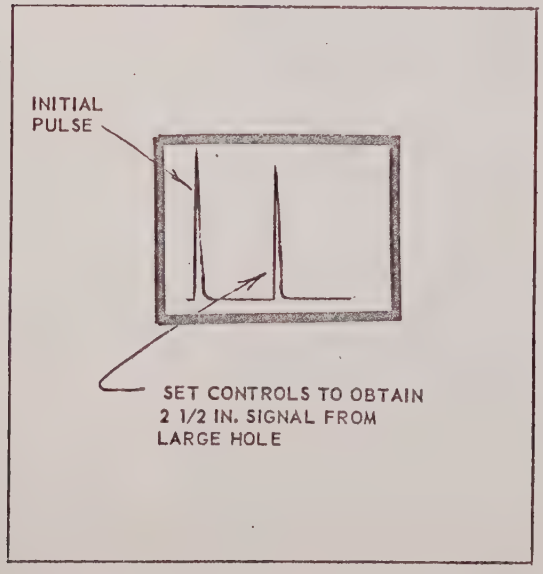


Figure 3-10 Various CRT Hole Reflections

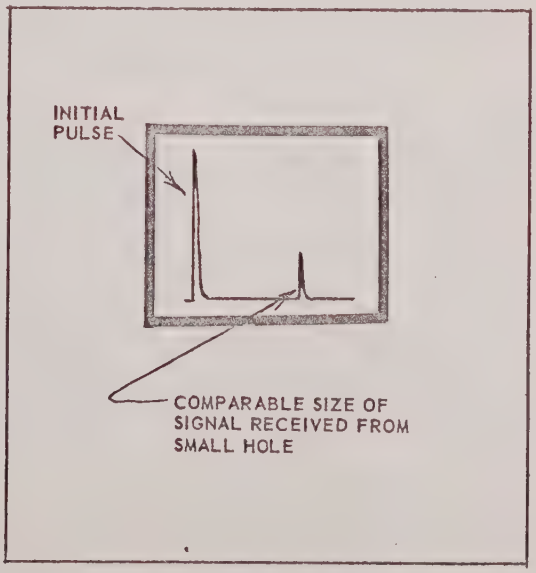


Figure 3-11 Various CRT Hole Reflections

(3) Move search unit over large hole and check number of divisions to hole indication.

(4) Slide search unit to the left along top of block until the reflection from the middle hole appears on CRT. Note that the hole is 3/4" (1 and 1/2 divisions) from the top surface. (Figure 3-7).

(5) Repeat above steps with search unit over other small hole.

(6) Turn block so that it rests on its three-inch surface (Figure 3 8). Place search unit on top surface so that only Back Reflection appears.

(7) Set Sweep to CAL X2. Note that Indication Display trace appears to move to the left. Position three back reflections on CRT. Check with scale calibration. This is set for 2 inches/div. Third reflection should occur at 6 divisions.

(8) Try several other measurement combinations. Check each measurement with the scale calibration.

(9) Review preceding steps until a thorough understanding of the use of a reference block, and scale calibration for measuring distance is attained.

(10) With search unit on 3" surface of block, increase sweep range controls and note that more indications appear on CRT. We are "seeing" more time, in other words the visible sweep represents a greater distance.

(11) Decrease sweep range controls and note that the indications move off screen to the right until only one Back Reflection is left. We now "see" less time or shorter distance.

(12) Place search unit on 3" surface of reference block to obtain Back Reflection.

(13) Increase Sweep Delay controls and note that the first Back Reflection moves toward the left side of screen. We are now seeing a segment of time further away beyond the position of the back Reflection. (Figure 3-9).

(14) Set Sweep range to CAL and .5 position and set Sweep Delay so initial pulse starts at first reference mark.

(15) With search unit over the large hole, set controls to obtain a 2 1/2" hole indication. (Figure 3-10).

(16) Move search unit over small hole and note the difference in size of hole indications. (Figure 3-11).

3.3.5 Angle Beam Testing Technique (Contact)

The procedure for familiarization with the angle beam technique is similar to that used for the straight beam technique. The angle beam search unit is designed so that the sound beam enters the material under test at an angle to the surface on which the search unit is applied. The following procedure should be used by a new operator in order to familiarize himself with the angle beam testing technique:

a. Set up the Reflectoscope for use. Allow warm-up period of five minutes.

b. Select a 2.25 MHZ type SMZ or a SW 45° angle beam search unit and attach to the search cable.

NOTE

When the angle beam SU is attached, the initial pulse broadens and small signals appear close to the initial pulse. This is a result of reverberations within the search unit. It is normal and these signals should not be confused with signals from defects or the back reflection.

c. Position controls of the Reflectoscope as follows:

(1)	Pulse Length	- 1/4 Turn cw.
(2)	Pulse Tuning*	- Adjust as required
(3)	Sweep	- X2 and 10 (Adjust as required)
(4)	Frequency*.	- 2.25 MHZ
(5)	Sensitivity	- (Adjust as required)
(6)	Reject	- OFF
(7)	Test Mode	- Echo or Normal
(8)	Long/Shear	- Shear

*Optional controls on Pulser/Receiver unit.

d. Place the standard test block so that the large hole faces you and is at the lower right.

e. Place a few drops of SAE 30 engine oil on the top surface of the block.

f. Place the 45° search unit on the block as shown in Figure 3-12. For most satisfactory results, the SU should be worked back and forth and, at the same time, twisted slightly side to side in a rotary motion so as to cover an arc of 20 to 30 degrees. This assures complete coverage of the material under test. (Figures 3-12 and 3-13).

g. Move the search unit slowly to the left end of the block until a picture similar to that in Figure 3-13 appears.

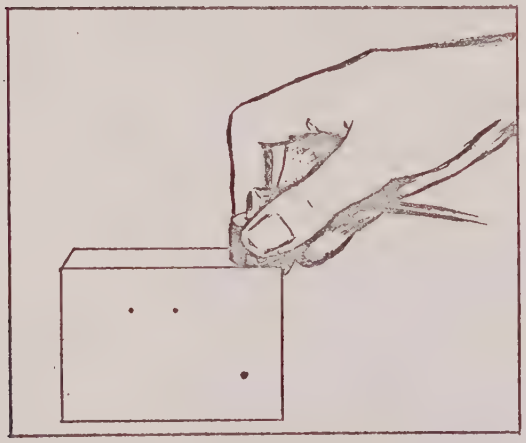


Figure 3-12 Angle Beam Search Unit Placed On Standard Test Block

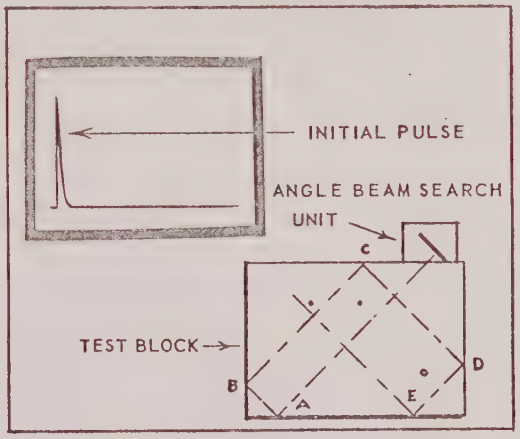


Figure 3-13 Path of Angle Sound Beam Through The Test Block. No Reflection From Holes

NOTE

The path of a beam at this time is shown in Figure 3-13. It will be seen that the beam is progressing from surface to surface inside the block from A to B etc. and that it fails to strike any defect surfaces which are in a position to reflect the sound beam back to the search unit. Eventually some of the sound beam may return to the search unit surface. However, because of attenuation or weakening of the beam as it travels through the material, the beam may be dissipated before the return path is completed. As mentioned in the preceding note, the operator will observe that several small indications appear along the base line when the SU is attached to the cable. These are due to reflections from within the search unit. Not all the sound energy passes through the plastic wedge of the search unit to the test surface. Some of it reflects around inside the wedge until it strikes the crystal, causing what appears to be a wide initial pulse even at a minimum Pulse Length setting. Additional small reflections appear when the Search unit is applied to the test block. These reflections are from the side of the test block and are due to the fact that the beam does not travel perfectly parallel, but fans out somewhat from the crystal face. The small return signal halfway out on the base line is a result of a portion of the beam reflecting from around point D directly back to the SU. This action becomes more understandable upon proceeding to the next step.

h. Slide the search unit slowly toward the left until a pattern similar to that shown in Figure 3-14 is attained.

NOTE

By checking back to the diagram of the sound path in Figure 3-13, the presence of the large reflection is easily understood. Careful observation of the screen may reveal a small reflection near the initial pulse. This can be explained by the fact that the .018 inch diameter by 1/2" deep hole in the middle of the block is being intercepted by the divergent sound beam.

i. Move the search unit further to the left. This will bring about a growth of the middle hole reflections and a reduction of the return from the opposite corner of the block. (See Figure 3-15).

j. Continue moving the search unit along the block until patterns similar to those shown in Figures 3-16 , 3-17 and 3-18 are obtained.

k. Repeat the foregoing procedure until complete familiarity with the angle beam search technique is attained.

3.3.6 THRU-TRANSMISSION (Two-crystal operation - contact)

a. Assemble the following items in addition to those required for single search unit operation:

(1) Standard 6' 4" cable.
(2) Two 4' 8" cables.
(3) Two straight beam search units of the same frequency (2.25MHz for this test).
(4) Aluminum block with saw cut notch. (See Figure 3-19).

b. Connect one end of a 6' 4" cable to the receptacle marked "R" and to the other and connect a 2.25MHz search unit. This becomes the Receiving search unit.

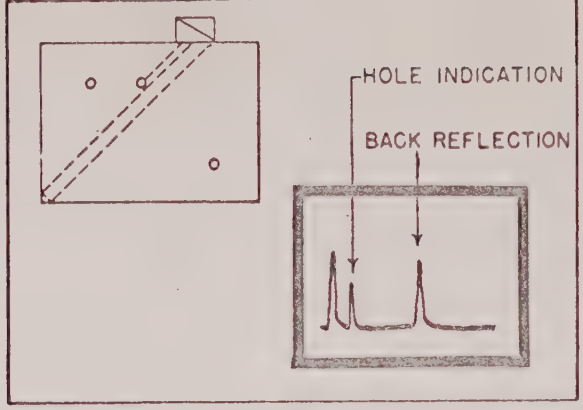


Figure 3-14 Beam Reflected From Middle Hole and From Corner of Test Block

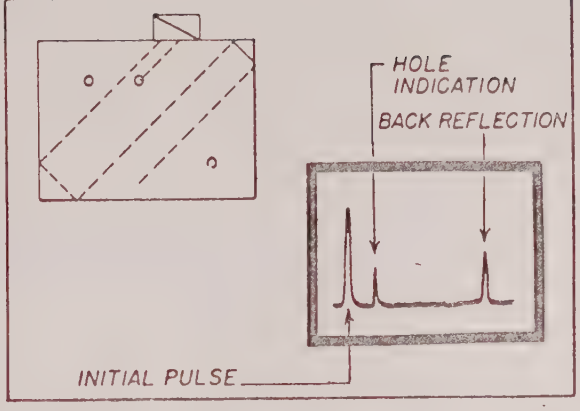


Figure 3-15 Increased Return From Middle Hole and Decreased Return from Corner Results In a Pattern As Above

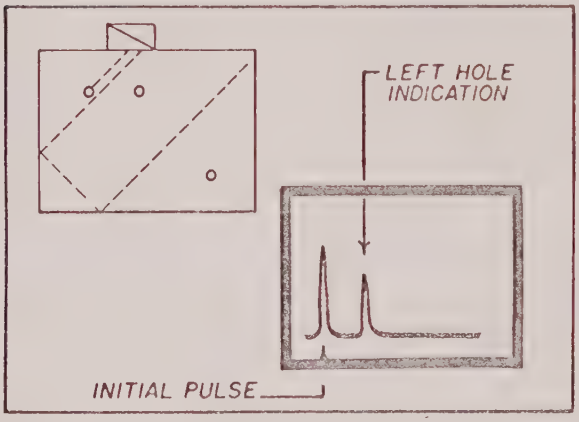


Figure 3-16 Reflection From Small Left Hand Hole

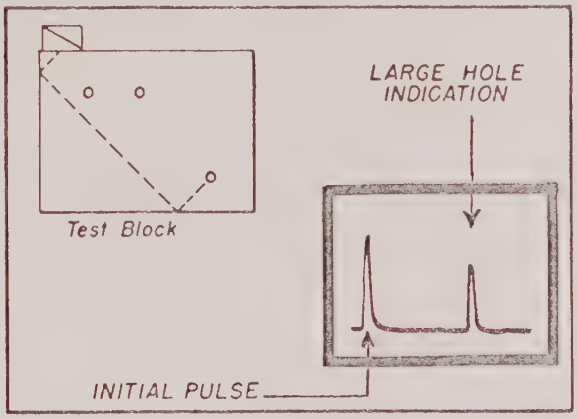


Figure 3-17 Reflection From Large Hole At Lower Right

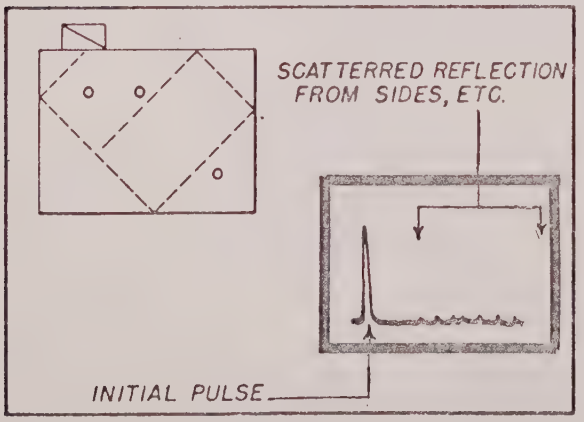


Figure 3-18 No Reflections Are Obtained When The Searching Unit is in the Position Shown Above

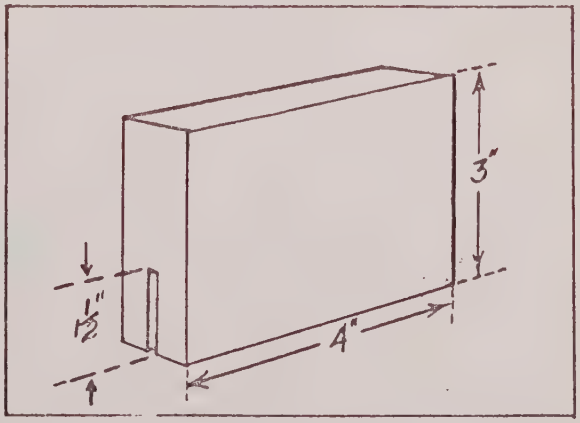


Figure 3-19 Aluminum Block with Saw Cut Notch

c. Connect one end of a 4' 8" cable to the receptacle marked "T" A 2.25MHz search unit is connected to the end of the second cable. (See Figure 3-20).

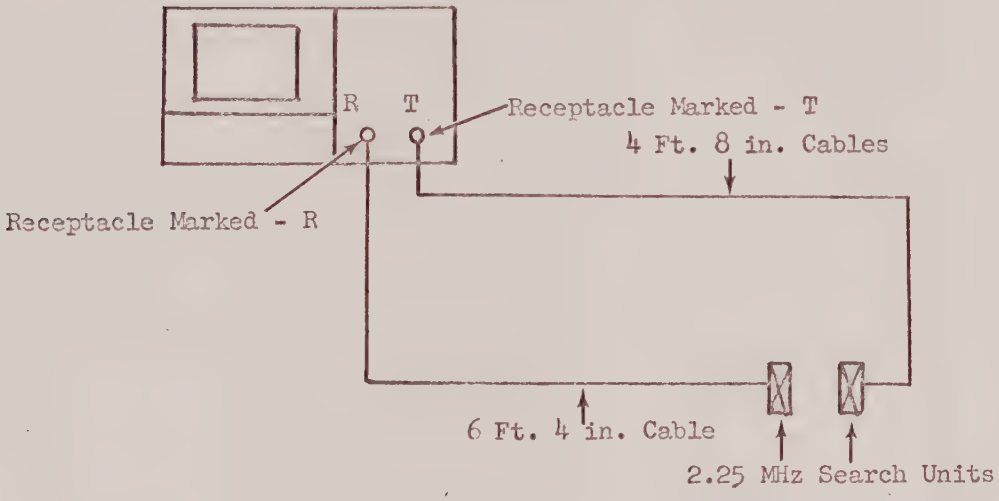


Figure 3-20 Cable Connections for Two Crystal (Thru-Transmission) Testing

d. Set controls as follows:

(1)	Sweep Range	- CAL and .1
(2)	Reject	- OFF
(3)	Pulse Length	- OFF
(4)	Frequency*	- 2.25 MHz
(5)	Sensitivity	- (As required 2" signal)
(6)	Test Mode	- THRU (transmission)
(7)	Pulse Tuning*	- Adjust for maximum signal amplitude.

*Optional controls on Pulser/Receiver Unit

e. Position the two search units on opposite sides of the block so that sound travels through the block in a direct line from the transmitting search unit to the receiving search unit.

NOTE

The CRT display shows indications from two sources, the initial pulse (transmitting search unit) and the sound striking the receiving search unit. (See Figure 3-21).

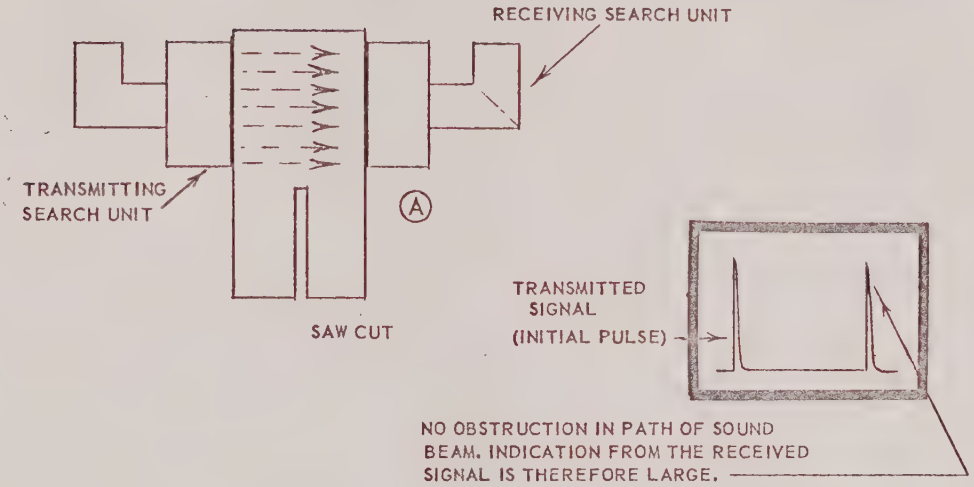

RECEIVING SEARCH UNIT
TRANSMITTING SEARCH UNIT
A
SAW CUT
TRANSMITTED SIGNAL (INITIAL PULSE)
NO OBSTRUCTION IN PATH OF SOUND BEAM. INDICATION FROM THE RECEIVED SIGNAL IS THEREFORE LARGE.

Figure 3-21 Thru Transmission - Position A

f. Move search units to position B (Figure 3-22). Note that the indication from the receiving search unit is reduced in size or completely deleted. The sound traveling through the block is obstructed by the saw cut and, therefore, less energy reaches the receiving search unit.

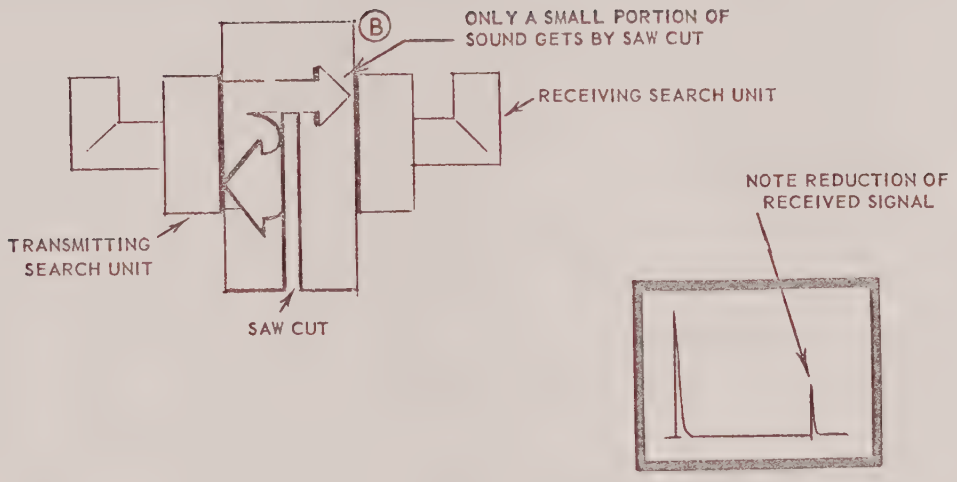

B
ONLY A SMALL PORTION OF SOUND GETS BY SAW CUT
RECEIVING SEARCH UNIT
NOTE REDUCTION OF RECEIVED SIGNAL
TRANSMITTING SEARCH UNIT
SAW CUT

Figure 3-22 Thru Transmission - Position B

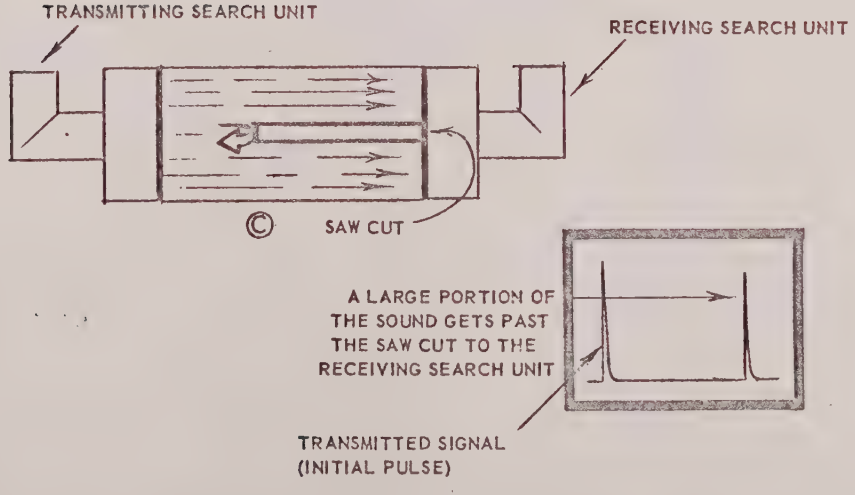

TRANSMITTING SEARCH UNIT
RECEIVING SEARCH UNIT
C
SAW CUT
A LARGE PORTION OF THE SOUND GETS PAST THE SAW CUT TO THE RECEIVING SEARCH UNIT
TRANSMITTED SIGNAL (INITIAL PULSE)

Figure 3-23 Thru Transmission - Position C

g. Place search units at position C (Figure 3-23). Adjust sweep length until indication appears at right of CRT. Note that the indication from receiving search unit is of greater amplitude than at position B. The saw cut presents less obstructing area scanned from position C than it does when scanned from position B; therefore, it must be borne in mind that even a small loss of amplitude of the received signal may be caused by a large discontinuity if the plane in which it lies is not normal to the sound beam.

3.3.7 SINGLE SEARCH UNIT IMMERSION TESTING

a. Assemble the following equipment:

(1) Immersion tank.
(2) Search unit positioner carriage.
(3) Search unit positioner.
(4) Immersion search units.
(5) Search unit handles.
(6) Standard 6' 4" search cable.
(7) Long search cable (25 feet).
(8) Match networks (as required).
(9) Test block.

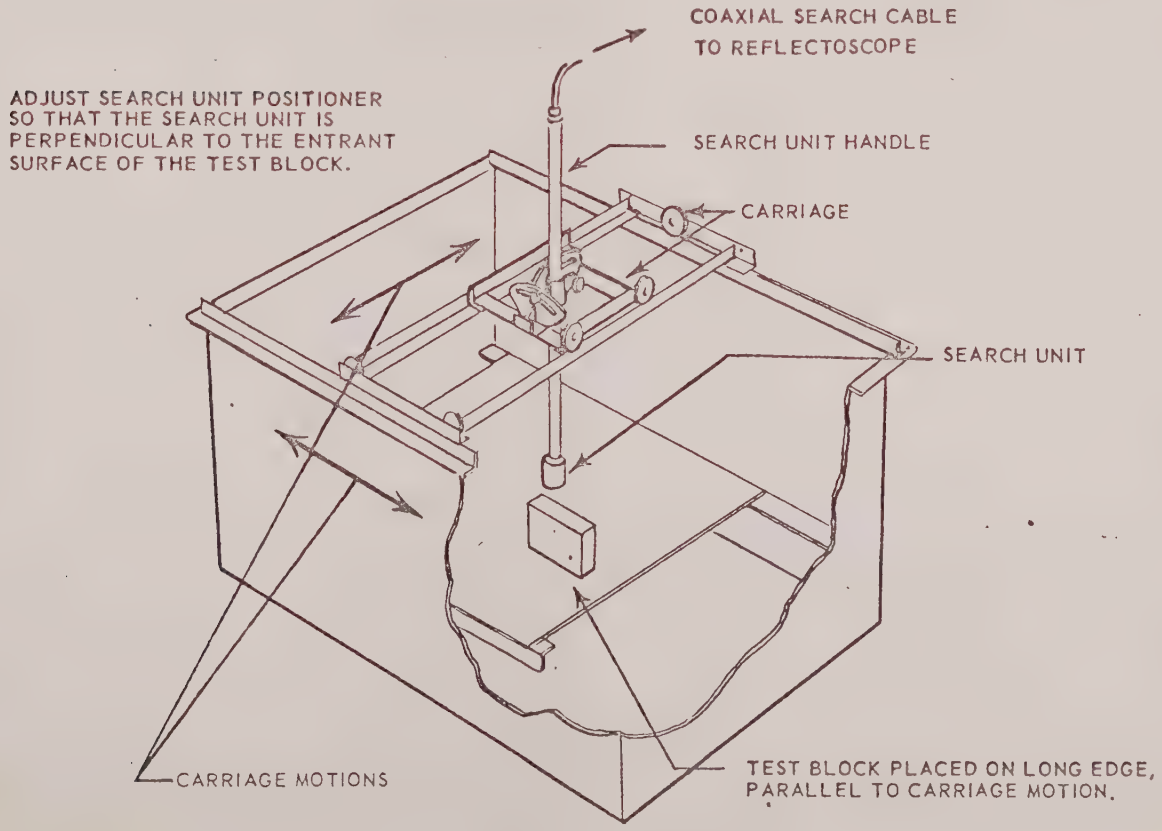

COAXIAL SEARCH CABLE TO REFLECTOSCOPE
ADJUST SEARCH UNIT POSITIONER SO THAT THE SEARCH UNIT IS PERPENDICULAR TO THE ENTRANT SURFACE OF THE TEST BLOCK.
SEARCH UNIT HANDLE
CARRIAGE
SEARCH UNIT
CARRIAGE MOTIONS
TEST BLOCK PLACED ON LONG EDGE, PARALLEL TO CARRIAGE MOTION.

Figure 3-24 Arrangement of Accessory Equipment for Single Search Unit Operation

b. Mount search unit positioner carriage on tank. (Figure 3-24).

c. Mount positioner on carriage.

d. Assemble 5.0 MHz 3/8" SI quartz search unit to a search unit handle, being sure "O" ring on search unit is in place.

e. Attach standard 6' 4" cable to search unit handle.

f. Attach other end of cable to receptacle marked "R" on Reflectoscope front panel.

NOTE

Turn connecting rings on search unit cable finger tight only.

g. Place test block in tank so that it is parallel to one of the carriage motions. (Figure 3-24).

h. Adjust positioner so that search unit is approximately 1 3/4" above surface of test block. (Figure 3-24).

i. Set front panel controls to following positions:

(1)	Frequency*	-	5.0 MHz
(2)	Sensitivity	-	(as required 2" signals)
(3)	Pulse Length	-	minimum
(4)	Pulse Tuning*	-	tune for maximum signal amplitude
(5)	Sweep Range	-	Cal and 2
(6)	Reject	-	OFF
(7)	Sweep Delay	-	Initial pulse at first index mark.
(8)	Test Mode	-	Normal or Echo

*Optional controls on Pulser/Receiver unit.

j. Position search unit by moving it over a section of the test block so that the sound beam will encounter no hole. Adjust the angular position of the search unit to obtain a signal of maximum amplitude from the bottom and top surface of the test block. (Figure 3-25).

k. Notice signal at left side of CRT. This is the initial pulse and is always visible unless more sweep delay is used.

l. The next large signal to the right of initial pulse is the surface signal or top surface of test block. The distance between the two signals is the distance the sound travels in water. (Figure 3-26).

m. Set Sweep Range for X2 and .1 (.2 inches/div.) Measure the distance from initial pulse to interface. Should be at most 9 divisions or 1.75".

n. Set Sweep Range to Cal and 2 or (2 inches/Div.).

o. The next signal after the interface indication is the first back reflection representing the bottom of the test block. The second signal to the right of the interface indication is the second back reflection. This is the second interface signal, i.e., it is a signal from

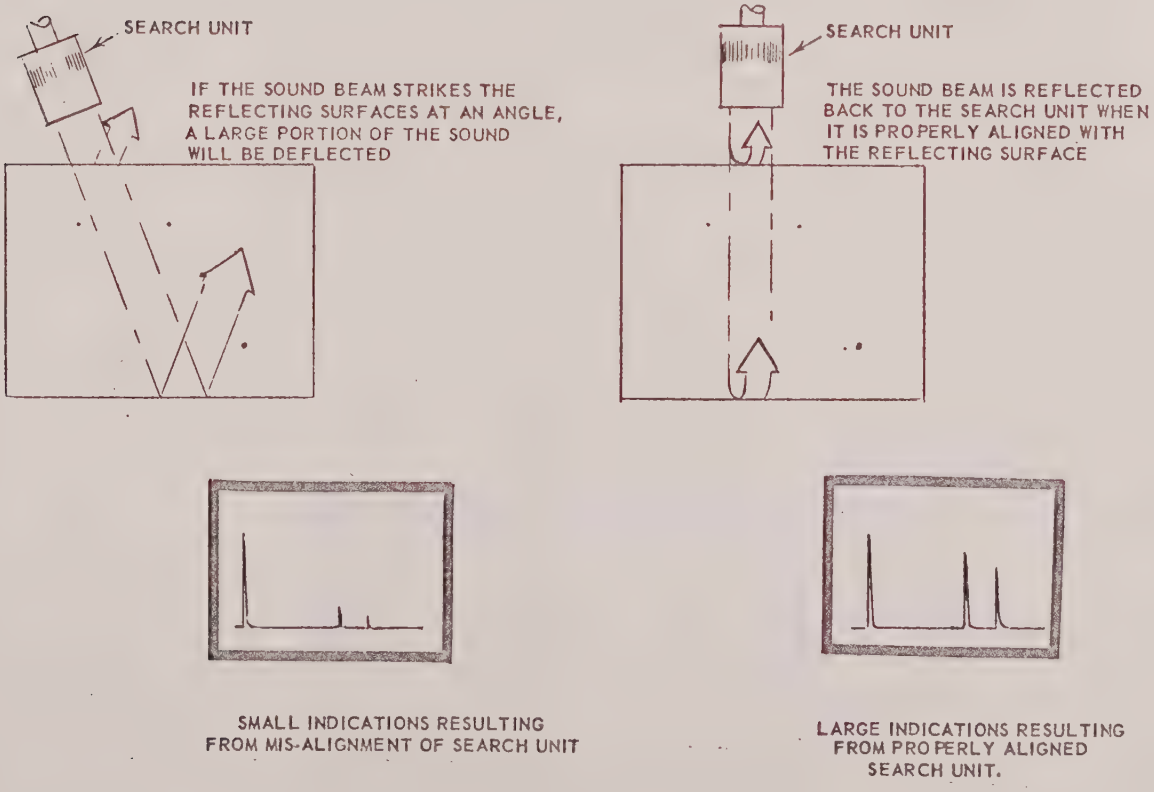

SEARCH UNIT
IF THE SOUND BEAM STRIKES THE REFLECTING SURFACES AT AN ANGLE, A LARGE PORTION OF THE SOUND WILL BE DEFLECTED
SEARCH UNIT
THE SOUND BEAM IS REFLECTED BACK TO THE SEARCH UNIT WHEN IT IS PROPERLY ALIGNED WITH THE REFLECTING SURFACE
SMALL INDICATIONS RESULTING FROM MIS-ALIGNMENT OF SEARCH UNIT
LARGE INDICATIONS RESULTING FROM PROPERLY ALIGNED SEARCH UNIT.

Figure 3-25 Positioning Search Unit for Maximum Penetration

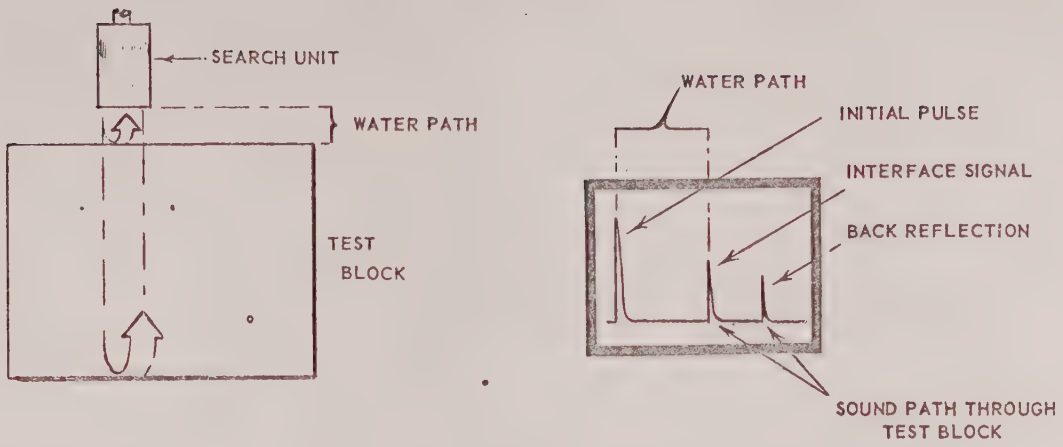


Figure 3-26 Sound Path Through Water and Test Block

the sound energy which has made two trips from the search unit to the top surface of the block and back. (Figure 3-27).

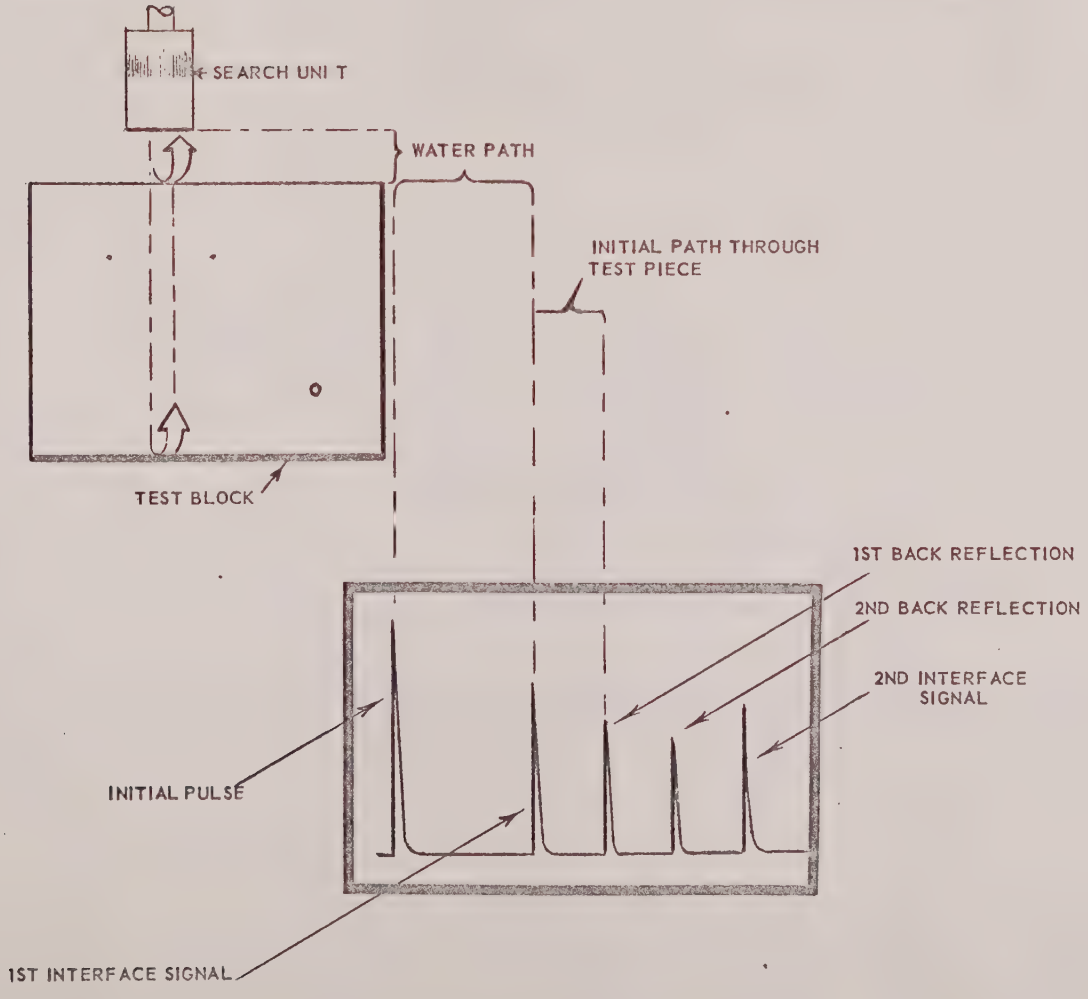


Figure 3-27 Signal Identification

NOTE

At this point, vary the water distance by moving search unit to and away from the test block. Observe that the distance between initial pulse and the interface signal varies and that the distance between the interface and the back reflection remains constant. The reason that the distance between the SU and top surface of reference block appears on the CRT as longer than the distance between top and bottom surfaces of the block, is that the velocity of sound through steel or aluminum is approximately 4 times that of the velocity of sound through water. Having identified these signals, position search unit so that the second interface echo falls to the right of the first back reflection.

p. Adjust Sweep Delay until first interface signal is at the left end of sweep line. (This eliminates initial pulse and water path from CRT screen.) (Figure 3-26.)

1ST BACK REFLECTION
1ST INTERFACE SIGNAL POSITIONED AT THE LEFT END OF SWEEP LINE
2ND BACK REFLECTION
2ND INTERFACE SIGNAL

Figure 3-28 Elimination of Initial Pulse and Water Path from CRT Screen

q. Adjust Sweep to move first back reflection to the right end of the sweep line, thus presenting on the CRT only the material depth. (Figure 3-29)

r. Move positioner over holes in block observing signals appearing between interface and back reflection, increasing sensitivity for desired signal amplitude.

s. Measurement of depth within the piece may be accomplished by the use of CRT gradicule reference lines. Align the leading edge of the interface signal instead of the initial pulse with the gradicule reference line.

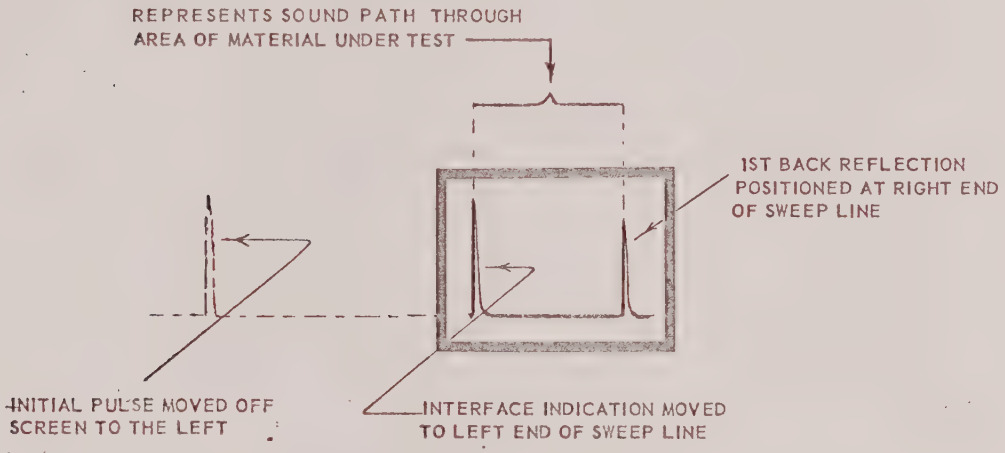

REPRESENTS SOUND PATH THROUGH AREA OF MATERIAL UNDER TEST
1ST BACK REFLECTION POSITIONED AT RIGHT END OF SWEEP LINE
INITIAL PULSE MOVED OFF SCREEN TO THE LEFT
INTERFACE INDICATION MOVED TO LEFT END OF SWEEP LINE

Figure 3-29 Use of Sweep Delay Position Interface Signal at Start of CRT Display

3.3.8 THRU-TRANSMISSION IMMERSION TESTING

a. In addition to the equipment listed in 3.6.a. proceeding, assemble the following:

(1) Standard 6' 4" search cable.
(2) Search unit handle
(3) Two right angle adapters.
(4) Search units (both of the same frequency).
(5) A fixture to hold search handles in place (Figure 3- 30). This is a suggested method of securing two search units on the tank if two positioners are not available.
(6) Test block with saw cuts. (Figure 3-31)

NOTE

Keeping the saw cut water tight by sealing with tape will result in easier signal interpretation.

b. Mount search unit adapters, search unit handles and positioning fixture on tank. Place aluminum block in tank as shown in Figure 3-32

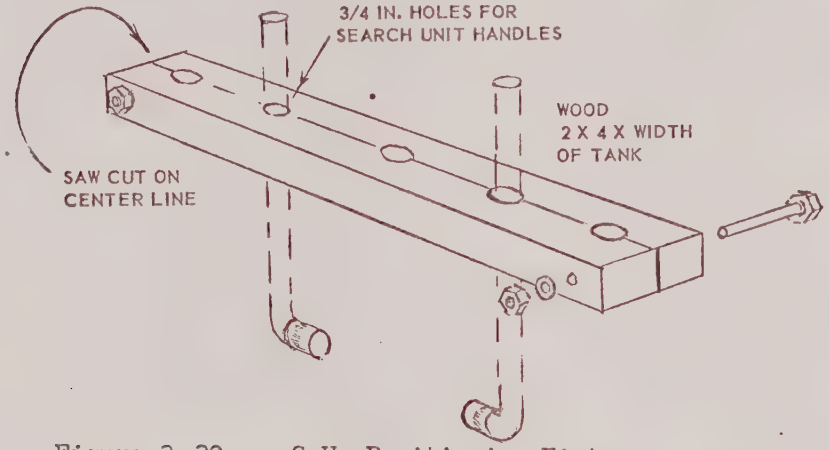


Figure 3-30 S.U. Positioning Fixture

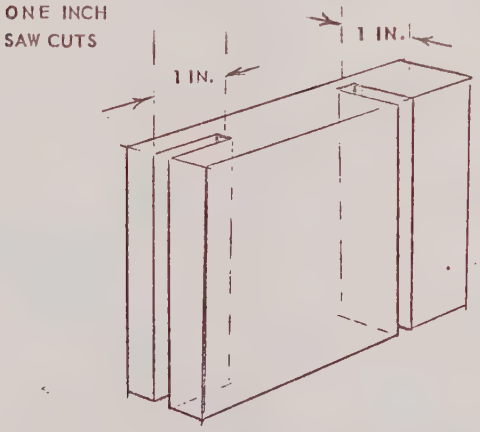


Figure 3-31 Aluminum Block

c. Connect one end of a standard 6' 4" cable to receptacle marked "R" and the other end to one of the search unit handles.

d. Connect one end of the second 6' 4" cable to receptacle marked "T" and the other end to the second search unit handle.

e. Set front panel controls to following positions:

(1) Sweep delay - set initial pulse on first index mark.
(2) Sweep - as required.
(3) Reject - OFF.
(4) Pulse length - ccw.
(5) Frequency* - 2.25 MHz
(6) Sensitivity - (as required 2" signal)
(7) Test Mode - THRU
*Optional control on Pulser/Receiver Unit.

f. Method of aligning Search units:

(1) Search units must be properly aligned so that the sound projected by the transmitting search unit will strike the receiving search unit. The CRT display shows indications from only two sources, the initial pulse and the sound striking the receiving crystal. This received signal must be brought to its optimum point by adjusting the search units until the greatest amount of the transmitted sound reaches the receiving search unit. (Figure 3-33)

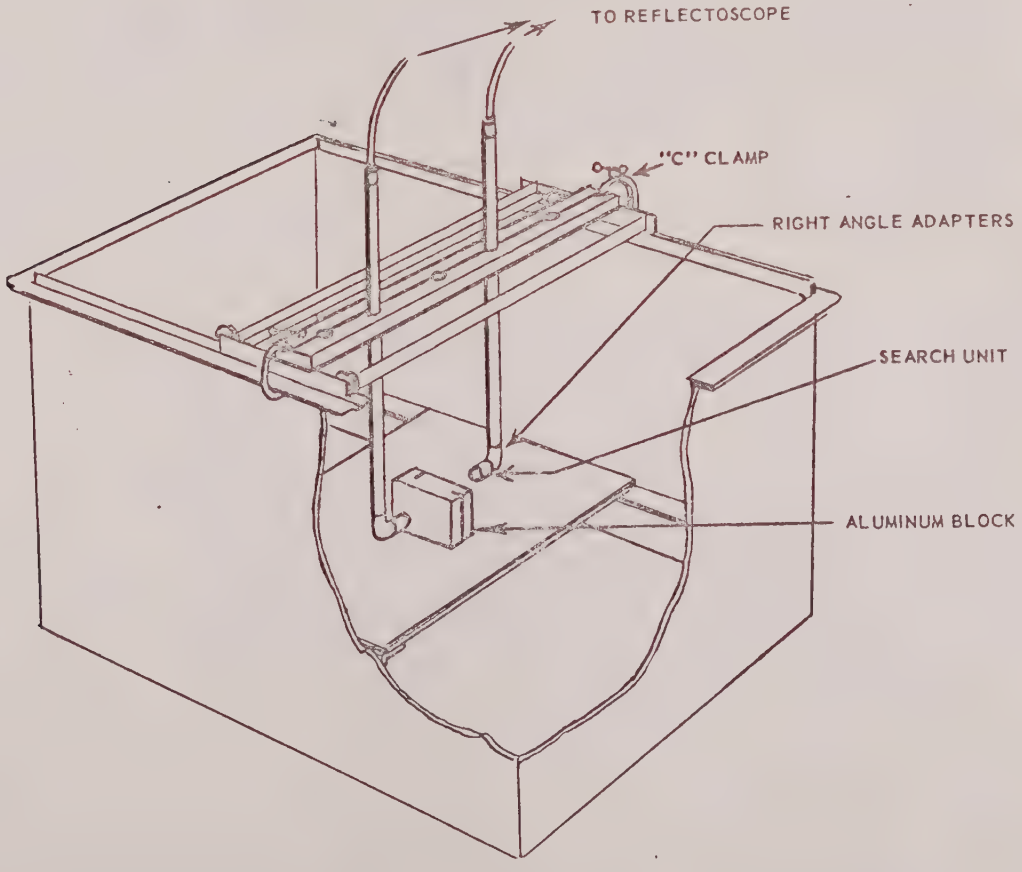


Figure 3-32 Arrangement of Accessory Equipment for Through Transmission

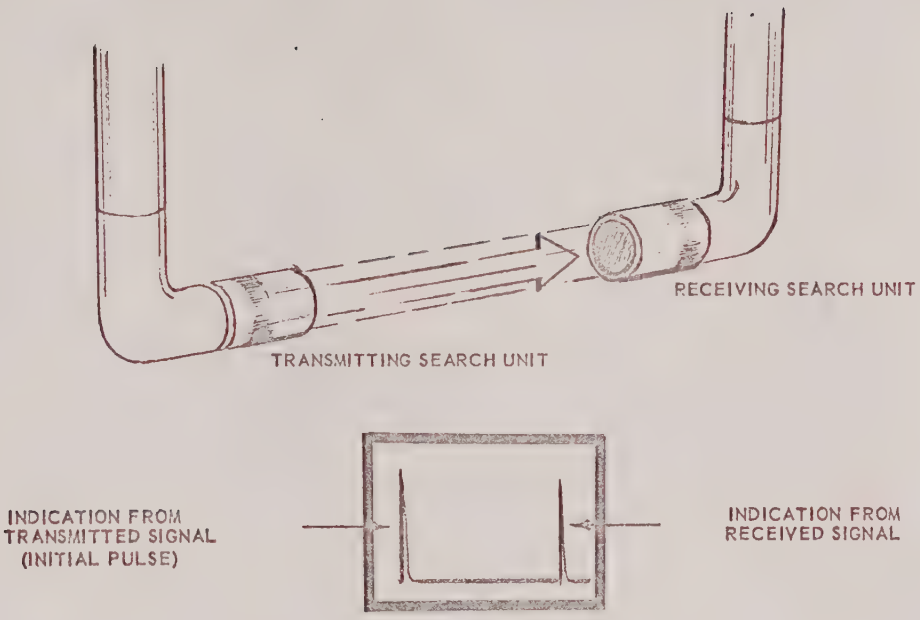

RECEIVING SEARCH UNIT
TRANSMITTING SEARCH UNIT
INDICATION FROM TRANSMITTED SIGNAL (INITIAL PULSE)
INDICATION FROM RECEIVED SIGNAL

Figure 3-33 Received Signals From Correctly Aligned Search Units

(2) Position search units so that the sound is directed at saw cut A. (Figure 3-34) Note that the indication from the received signal is reduced in size according to the amount of sound cut off by the saw cut (plan view).

(3) Position search units so that sound is directed at end of saw cut B. (Figure 3-35) Note that although the saw cuts are of equal dimensions, the indication is much larger when sound is directed at saw cut B. The plan view in Figure 3-33 shows only a small portion of the sound being obstructed by the narrow face presented by the saw cut B.

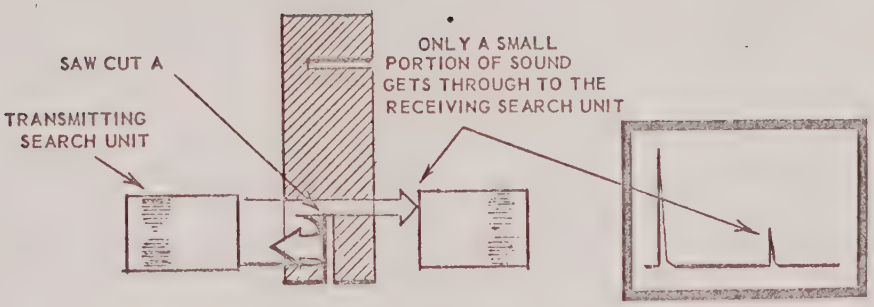


Figure 3-34 Received CRT Waveform

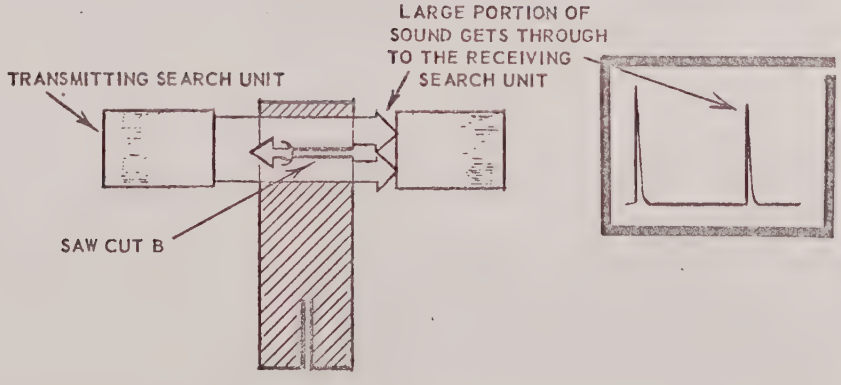


Figure 3-35 Received CRT Waveform

CHAPTER 4

ELECTRICAL DESCRIPTION

4.1 GENERAL

This section describes the theory of operation of the CRT Display UM-771/775 Reflectoscope. This chapter used in conjunction with Chapter 5, Maintenance, will be helpful in troubleshooting the UM-771/775 Reflectoscope for any malfunctions.

4.2 THEORY OF OPERATION - GENERAL

4.2.1 There are two separate power supplies; a low-voltage power supply and a high voltage power supply. The outputs of the low voltage power supply are used by every major assembly in the display, timing, Pulser/Receiver Plug-in, and Accessory plug-in module. The output of the high voltage power supply is used for operation of the CRT.

The UM-771/775 Reflectoscope uses two fuses for Transformer T-101 and low voltage power supply protection. See Reference Schematic 50E618 for proper replacement of fuses. The power transformer T-101 in the UM-775 is different than the one used in the UM-771. The differences are physical size, power handle capability and mountings.

4.2.2 Input AC voltage is connected to J107 at the rear of the UM-771/775 Reflectoscope unit, it also passes thru F101 and F102 to the ON and OFF Switch S101 and B101. By energizing S101, AC Voltage is impressed on the Primaries of A and B Section, and on fan B101. Options for 115 and 230 VAC input can be performed by simply changing the primary taps at P104 (See Chapter 2 Section 2.4.2.1).

4.2.3 Low Voltage Power Supply

The low voltage power supply has six regulated outputs which are used as follows:

a. 300V ..... Used in the high voltage power supply, ASTIGMATISM, Geometry and intensity circuits, and is also used as Plate Voltage for Pulser/Receiver Pult-in units.

b. 150V ..... Used in the High Voltage Power Supply, and Deflection Amplifier. Also used as Plate voltage for Pulser/Receiver Pulg-in units.

c. -108V ..... This voltage is used for various pulser/receiver units.

d. 75V ..... Used in the Horizontal - Vertical Deflection amplifier for transistor biasing.

e. 12V ..... Used in all assemblies.

f. -12V ..... Used in all assemblies.

4.2.3.1 Low Voltage Power Supply Components

Physically, the low voltage power supply components are located in the rear of the instrument chassis. There are two major sub-assemblies:

a. Power Transformer ..... Power transformer contains various set-up and step-down AC voltages sent to the Low Voltage Power Supply P.C. Board Assembly 50D568.

b. Low Voltage Power Supply..... This board contains components which rectifiers and regulates the six Low Voltage outputs. All the low Voltages are adjustable except the 75V. All supply out-put voltages are individually fused to protect power supply circuits. See Table 4-1 for the Low Voltage Power Supply Fuse list.

TABLE 4-1

LOW VOLTAGE POWER SUPPLY FUSE LIST

Power Supply Section	Fuse	Value
+300VDC	F201	1/2 Amp
+150VDC	F202	1/2 Amp
-108VDC	F203	1/4 Amp
+75VDC	F204	1/4 Amp
+12VDC	F205	2 Amp
-12VDC	F206	2 Amp

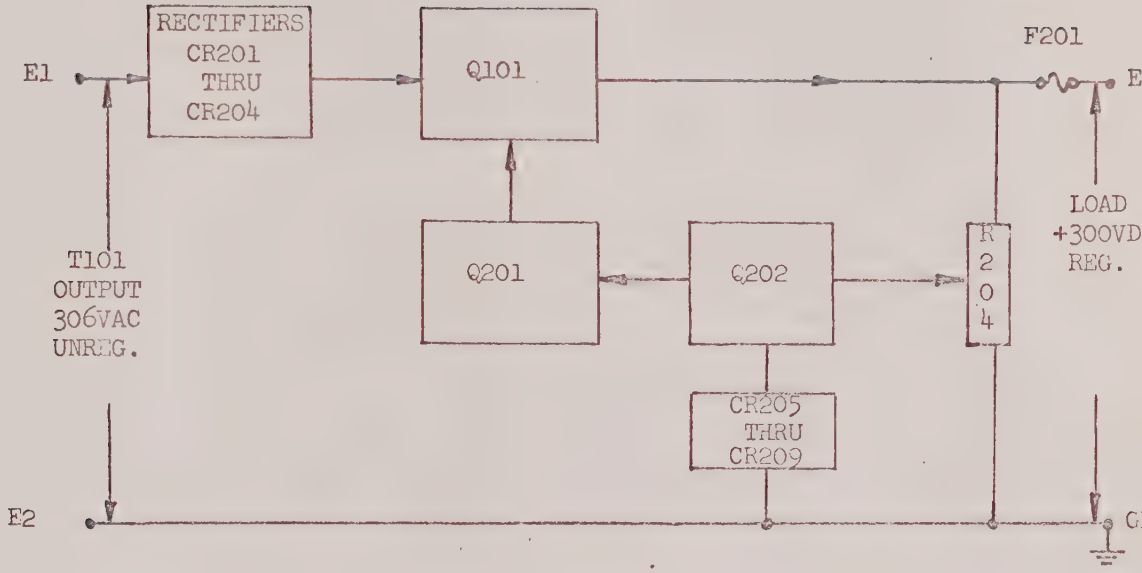


Figure 4-1 Block Diagram of the +300VDC Regulation Circuit

4.3 THEORY OF OPERATION - DETAILED

4.3.1. Circuit Description of the Low Voltage Power Supply (See Reference Schematic No. 50E618, and Low Voltage Block Diagram 4-2).

a. Circuits for the 300V, 150V and -108V power supply are basically the same. The 300V power supply will be explained in detail. The 300V output of the low voltage power supply is developed in a full wave rectifier circuit composed of CR201 thru CR204. All electrical components are located on the Low Voltage P.C. Board except transistor Q101 thru Q105 which are located at the rear of the Reflectoscope heat sink. Capacitor C201 filters the full wave output voltage. A positive voltage with respect to ground appears at the collector imput of the series regulator, and base of Q201 and Q202 through dropping resistor R201. These transistors detect the output fluctuations and control the conduction of the series regulator transistor Q101.

The emitter of Q202 is held at a constant reference voltage by Zener diodes CR205 thru CR209. Q202 is collector coupled to Base of Q201. The base of Q202 is connected to the center tap of a voltage divider connected across the output of the 300 volt power supply. As the load on the supply changes, the current through the divider changes varying the conduction of Q202. The voltage changes at the collector of Q202 are directly coupled to the base of Q201, an emitter follower. Q201 drives the series regulator, Q101, which acts as a variable resistor in series with the load to keep the output voltage at a constant level (300V).

The 300 D.C. output voltage is sent to the low voltage board J201 for voltage distribution within the UM-771/775 reflectoscope.

b. The 75V power supply is the same as the 300V circuit except there is no voltage adjustment on the 75V regulated output circuit.

c. Plus and minus 12 volt power supply (See Figure 4-2). The plus and minus 12 VDC outputs of the low voltage power supply are developed in a full wave rectifier circuit composed of CR228 thru CR231. Capacitors C216 and C220 filter the full wave output, and a ground point is established between the two capacitors.

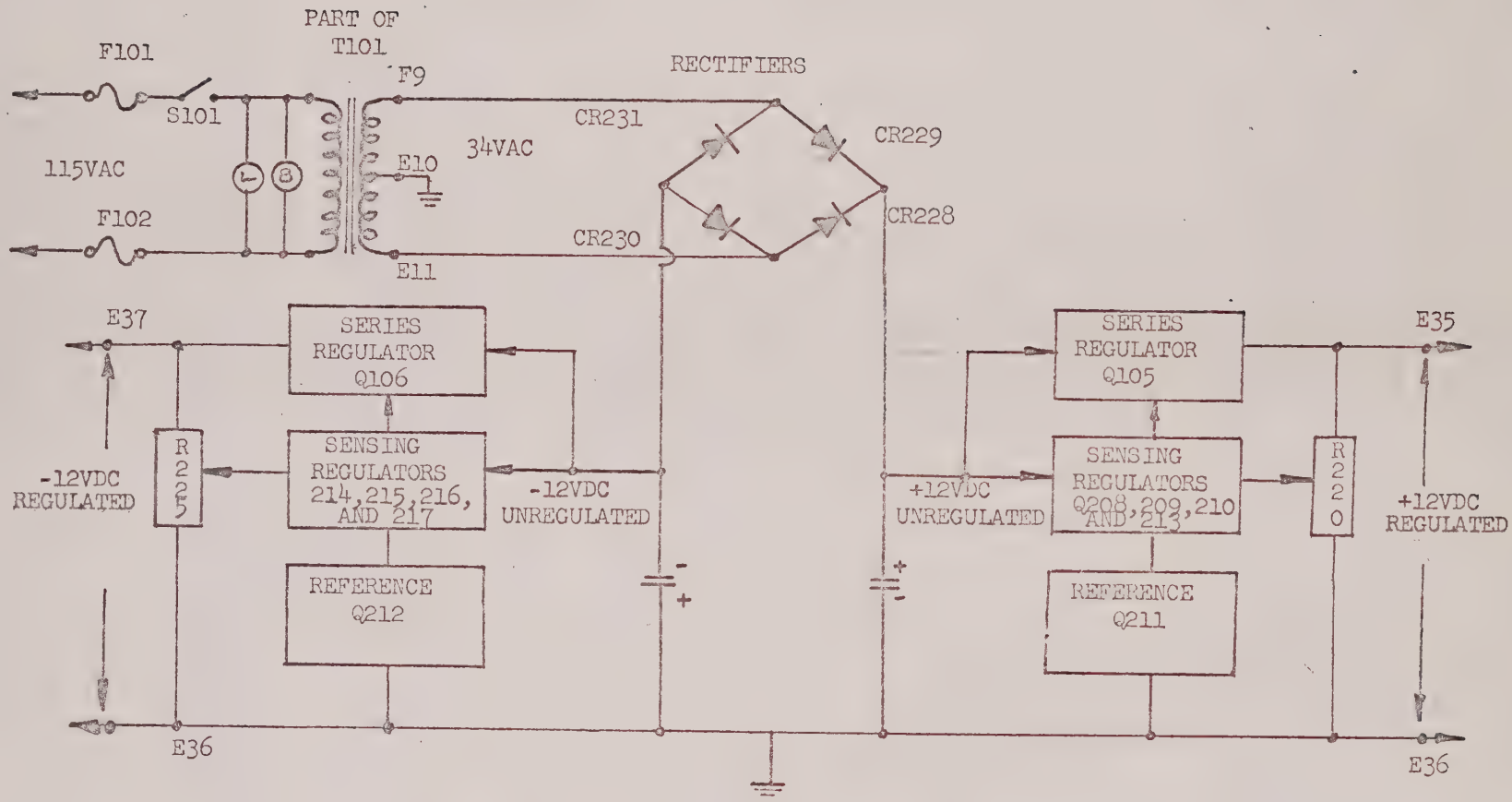


Figure 4-2 Simplified Block Diagram of the ±12VDC Power Supply Circuit

A positive voltage with respect to ground appears across C219. The unregulated positive voltage is applied to Q208, Q209, Q210, and Q213. These transistors detect the output fluctuations and control the conduction of the series regulator transistor Q105.

The emitter of Q210 and Q213 is held at a constant reference voltage by transistor Q211. The base of Q213 is connected to the center tap of a voltage divider connected across the output of the plus 12 volt power supply. As the load on the power supply changes, the current through the divider changes varying the conduction of Q210 and Q213. Voltage changes at the collector of Q210 and Q213 are directly coupled to the base of Q209, and enitter follower. The output of Q209 is fed to another emitter follower, Q208. This Q208 drives the series regulator Q105 which acts as a variable resistor in series with the load to keep the output voltage at a constant 12VDC.

The negative output from C220 is regulated by applying this voltage to the sensing and regulating transistors. This circuit is nearly the same as the positive regulator circuit except for those changes required by the use of PNP Type transistors Q106, Q216 and Q217 instead of NPN used in the positive voltage supply regulator. The output of Q217 controls the conduction of the series regulator Q106 to keep the minus 12VDC output constant.

4.3.2 High Voltage Power Supply and Unblanking Circuits

a. The High Voltage Power Supply provides control grid bias accelerating and unblanking voltages for the CRT. High voltage power supply is located on the right side of the CRT. Removal of the top instrument wrap-around cover allows access to the power supply components.

b. Circuit Description of the high voltage power supply and unblanking circuits (See Reference Schematic No. 50E618, and Figure 4-3 High Voltage Power Supply Block Diagram).

CAUTION

When measuring voltages in the High Voltage Power supply, Maintenance Section Personnel should exercise extreme CAUTION. Voltages Hazardous to life are present.

The High Voltage Power Supply is made up of a saturable-core square wave oscillator Q301 and Q302 whose tuned circuit includes the primary of a high voltage transformer T301. One step-up secondary winding feed two high voltage circuits which develop the D.C. voltages for the CRT.

c. The saturable-core square wave oscillator circuit Q301 and Q302 operates at about 20 KHz. It supplies approximately 16V Peak to Peak to the primary of Transformer, T301. The Secondary of the transformer supplies AC High Voltage. High Voltage is supplied to a half wave rectifier circuit CR303 at approximately -1.9 KV and to a high voltage doubler circuit Q302 and CR301 at approximately 4.1 KV.

The voltage doubler circuit in combination with the single halfwave rectifier, provides a total accelerating voltage of 5680VDC to the CRT. A positive 4,100 VDC is supplied to the CRT postanode accelerator by the doubler circuit and a negative 1580VDC is supplied to the CRT cathode, making a total potential difference of 5680VDC between the cathode and post anode accelerator.

d. The high voltage power supply -1910V is adjusted by voltage dropping resistor R-332. This controlled voltage output is tied to the Gate of the field effect transistor Q305. The output of Q305 controls the output voltage of Q307 and Q306 in turn controlling the amplitude output of the inverter circuit (saturable - core square wave oscillator).

e. A floating supply is required in order to provide DC coupling for the unblanking voltage to the CRT control grid. The unblanking pulse is superimposed on the CRT control grid voltage through Q304, Q303 and VR308. The unblanking wave form figure 4-6 as seen at the plus side of VR308.

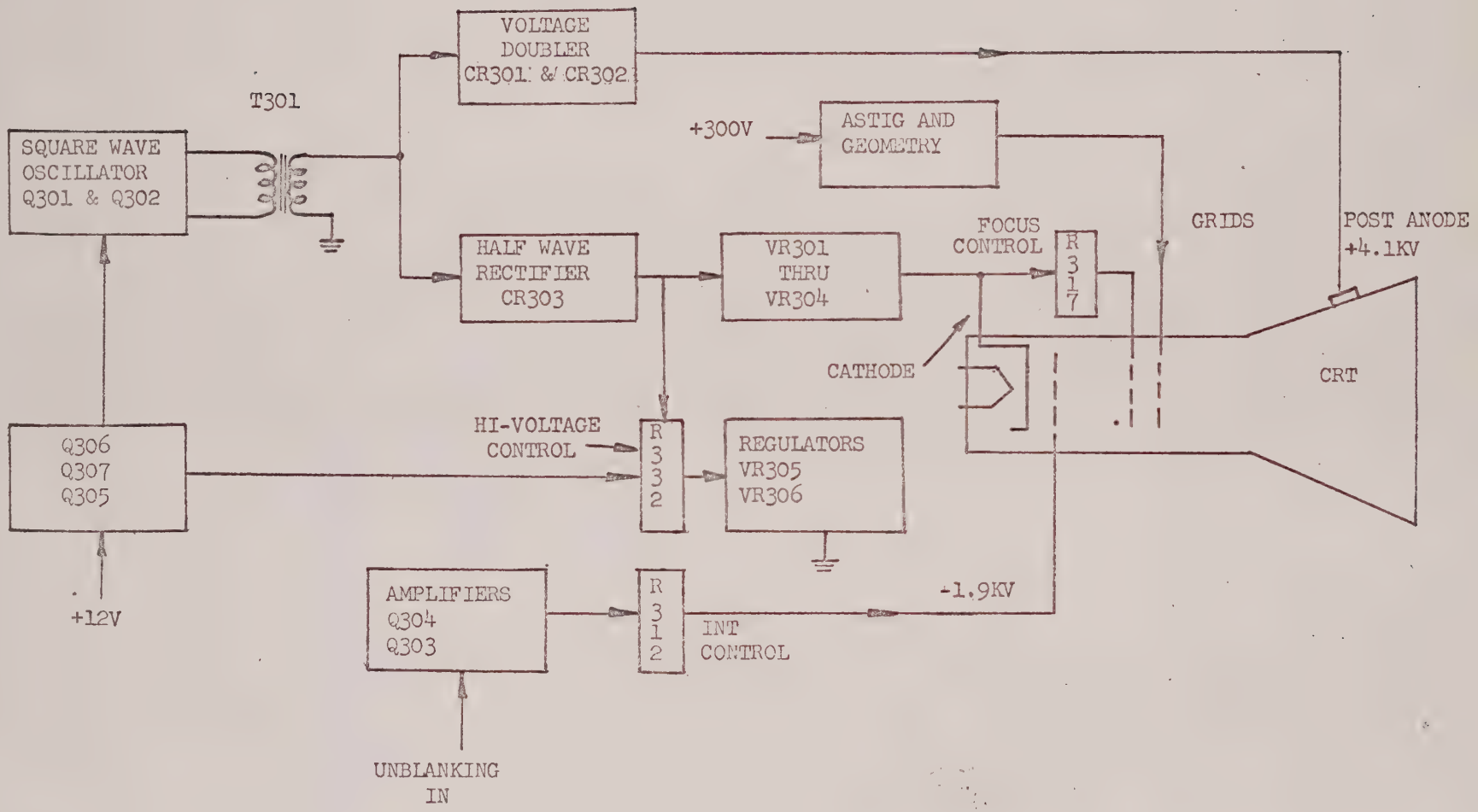
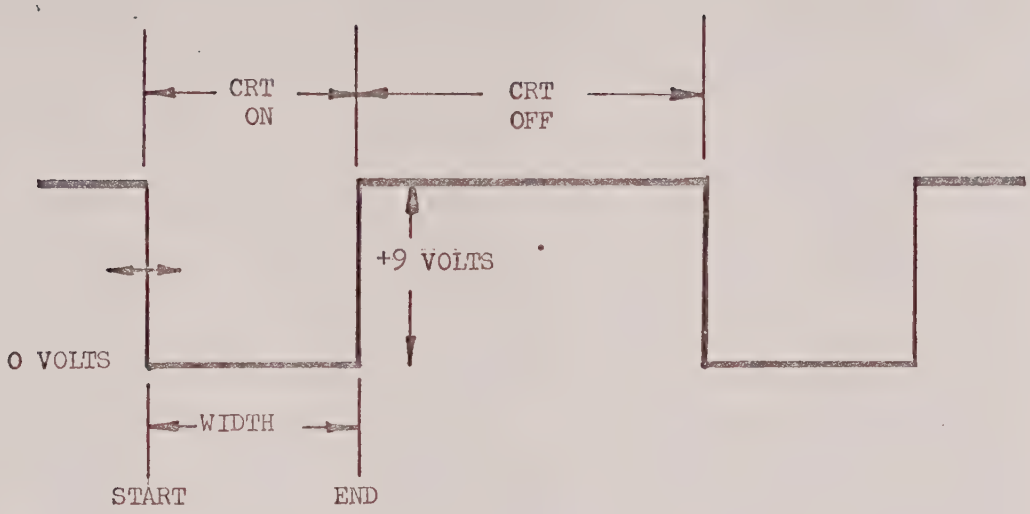


Figure 4-3 Block Diagram of the High Voltage Power Supply and Unblanking Circuit



WIDTH is controlled by Sweep Length ADJUST
START is controlled by Sweep Delay ADJUST

Figure 4-4. Unblanking Waveform at the Input E2 of the High Voltage Board

f. The filaments 6.3VAC for the CRT are obtained from the secondary of T101. During normal operation the filament voltage 6.3 VAC is floating on a high voltage potential of -1500 VDC.

CAUTION

With the instrument in the ON position, Caution should be taken when measuring CRT Filament Voltage.

g. The focus, astigamatism and geometry circuits control the grid voltages to the CRT for proper sweep presentation functions.

h. Listed in Chart 4-1 are various CRT Voltage pontentials (See figure 4-5, schematic of the CRT circuit).

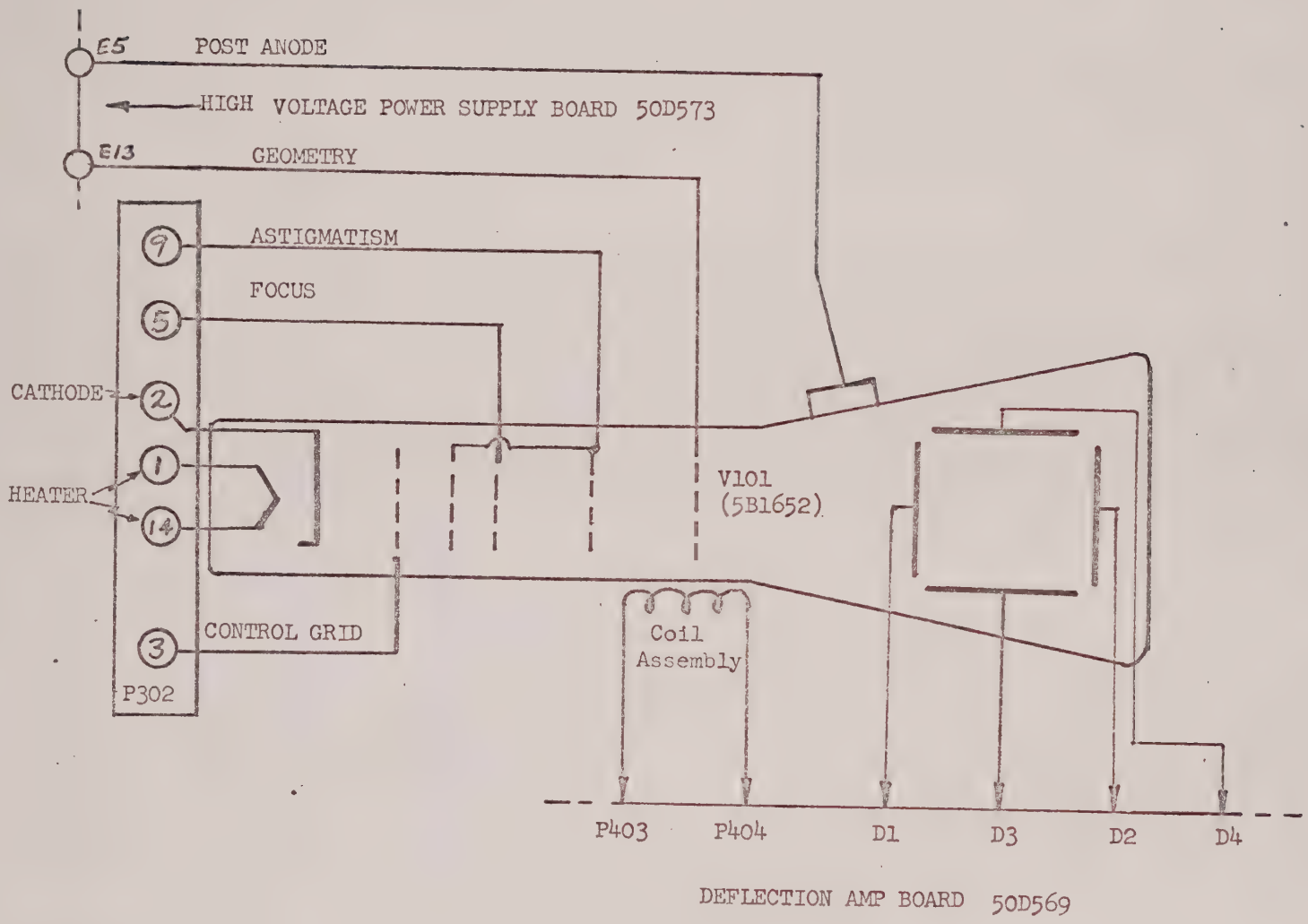


Figure 4-5 Schematic of the CRT Circuit

CHART 4-1

Various CRT Voltage Potentials

CRT Element	Location	Voltage
Control Grid (Caution, Do Not Measure)	E8 P302	-1580 VDC (Approx.)
Heaters	Pins 14 & 1 P302	6.3 VAC
Cathode	E12 (Hi Voltage Bd.)	-1580 VDC
Focus	E9 (Hi Voltage Bd.)	-1300 VDC
Astigmatism	E10 (Hi Voltage Bd.)	300 VDC (Approx.)
Geometry	E13 (Hi Voltage Bd.)	300 VDC (Approx.)
Post Anode	E5 (Hi Voltage Bd.)	4,100 VDC
Trace Coil Ass'y	P403-P404	12 VDC (Approx.)
Vert Plates	D3-D4	35 VDC (Approx.)
Horiz. Plates	D1-D2	75 VDC (Approx.)

NOTE

Voltage measurements are made with respect to the DC power supply ground.

4.3.3 Deflection Amplifiers. The Horizontal and Vertical circuits are mounted on the same circuit board. The vertical and horizontal board is located in the lower left section of the Display unit. (See Reference Schematic 50E618, Figure 4-6).

4.3.3.1 Horizontal Deflection Amplifier

The purpose of the horizontal deflection amplifier is:

a. To amplify 5 volt peak from the sweep generator to approximately 140 volt peak.

b. To provide a differential output to drive the Horizontal deflection plates of the CRT.

c. To provide a Horizontal positioning trace on the CRT.

In the delay or video sync mode the calibrated sweep generator is connected to the input of the horizontal amplifier. Q404 is an emitter follower which drives the emitter coupled differential amplifiers (Q402 and Q403). Emitter follower Q401 is used as a buffer for the horizontal positioning control. As the horizontal positioning control (located in the Timer unit) is rotated, this changes the bias to the Base of the differential amplifier Q402 shifting the position of the Trace horizontially on the screen. R402 Horizontal Gain is adjusted so that the gain of Q402 and Q403 are equal to the gain required for proper horizontal deflection on CRT. D1 and D2 are connected directly to the Horizontal deflection amplifier section. Horizontal sink bias R403 is adjusted for 28 ma current through R401 to assure adequate Horizontal deflection, so that a 5.0 volt peak signal on the imput (J402-X) equals more than a 10 cm deflection on the CRT. Horizontal Trace alignment R411 is used to align the horizontal Trace parallel to the internal gradicule line. All operating voltages for the Horizontal Deflection Amplifier are obtained from the low voltage power supply board.

4.3.3.1 Vertical Deflection Amplifier. (See Deflection Amplifier Schematic Figure 4-7 and Figure 4-8).

The purpose of the vertical deflection amplifier is:

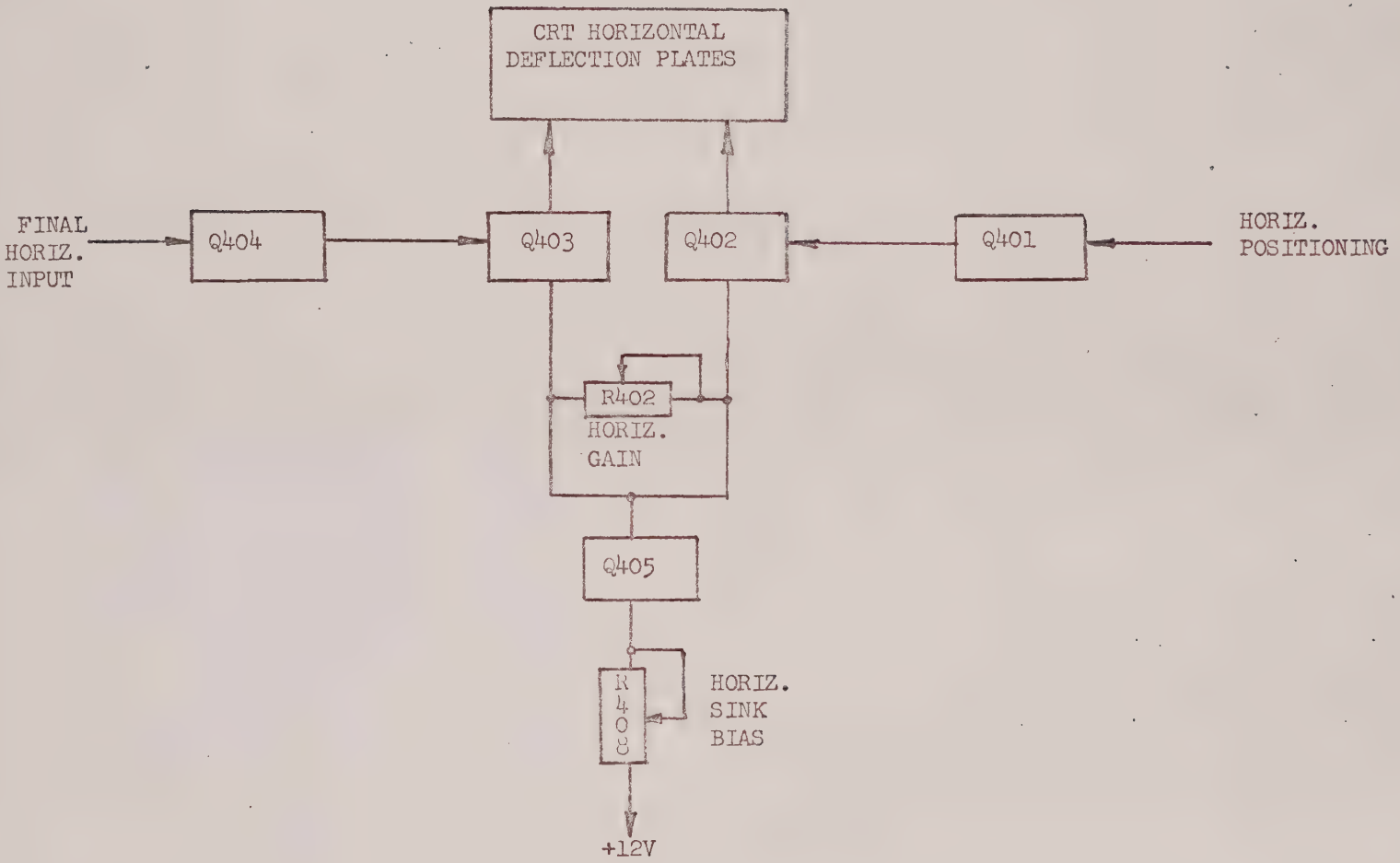


Figure 4-6 Block Diagram of the Horizontal Amplifier Circuit

a. To amplify the video signals from the receiver final vertical input 6.5 V Peak to approximately 56 volt peak.

b. To provide a differential output to drive the vertical deflection plates of the CRT.

c. To provide a vertical positioning Trace on the CRT.

d. To provide vertical summing inputs of display marks, steps input gates input and Vertical positioning.

e. To provide a second trace input.

The differential amplifier Q409 and Q412 drives the output of Q410 and Q411 which are connected to the CRT vertical deflection plates. The final output to the deflection plates are felt at the collectors of Q410 and Q411, (D3 and D4). Vertical gain R443 is adjusted so that the gain of Q410 and Q411 are equal to the required amplitude signals at the collectors for proper vertical deflection on CRT. Vertical sink bias R450 is adjusted for approximately 88 ma input collector current thru R419, which will give proper vertical signal deflection.

Display marks, vertical positioning, step and gate inputs (Vertical index summing) are various inputs to the Emitter follower Q415. The vertical index summing signal or signals are then fed to one side of the differential amplifier Base Q412.

Final vertical input to the base of Q409 is a 6.5 volt peak signal selecting video, RF (wave form 5) DAC (Waveform 7) or a combination of video and DAC (Waveform 5 and 6) for vertical display. See figure 4-11 for the various vertical waveform signals. Early sync waveform (2) a positive and negative going signal, is impressed on to the base of Q406 and Q408, acts as a switching device. When the positive signal of waveform (2) is sent to the base of Q406, foward biasing the transistor will connect Video/RF Waveform (5) to the input of J101-8 to Final Vertical input circuit. When the negative signal of waveform (2) is sent to the base of Q 408, forward biasing the transistor will connect, Vertical Auxiliary input to the final vertical input circuit. When Q408 is foward bias, Q406 is in reverse bias closing the circuit input to Q406.

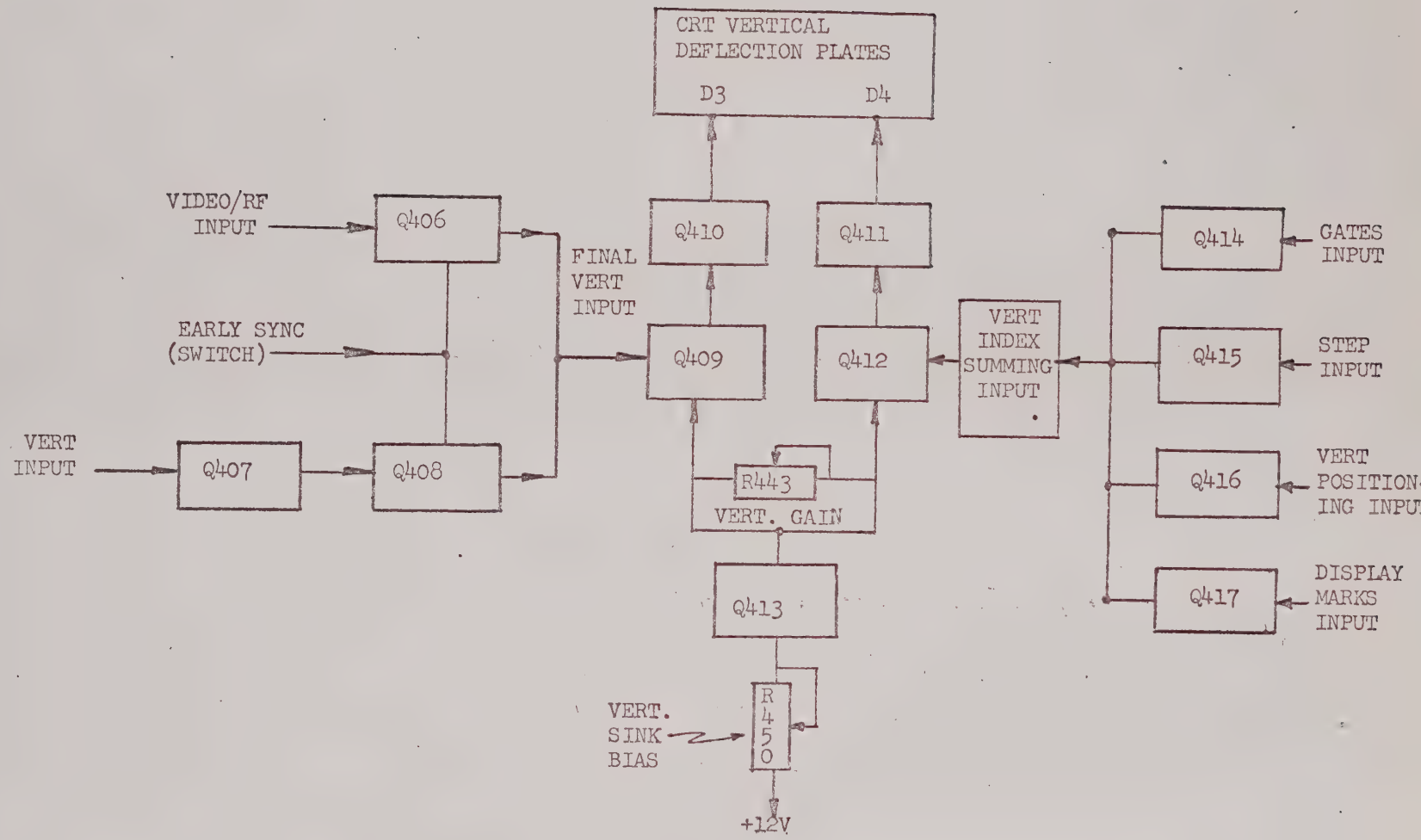


Figure 4-7 Block Diagram of the Vertical Amplifier Circuit

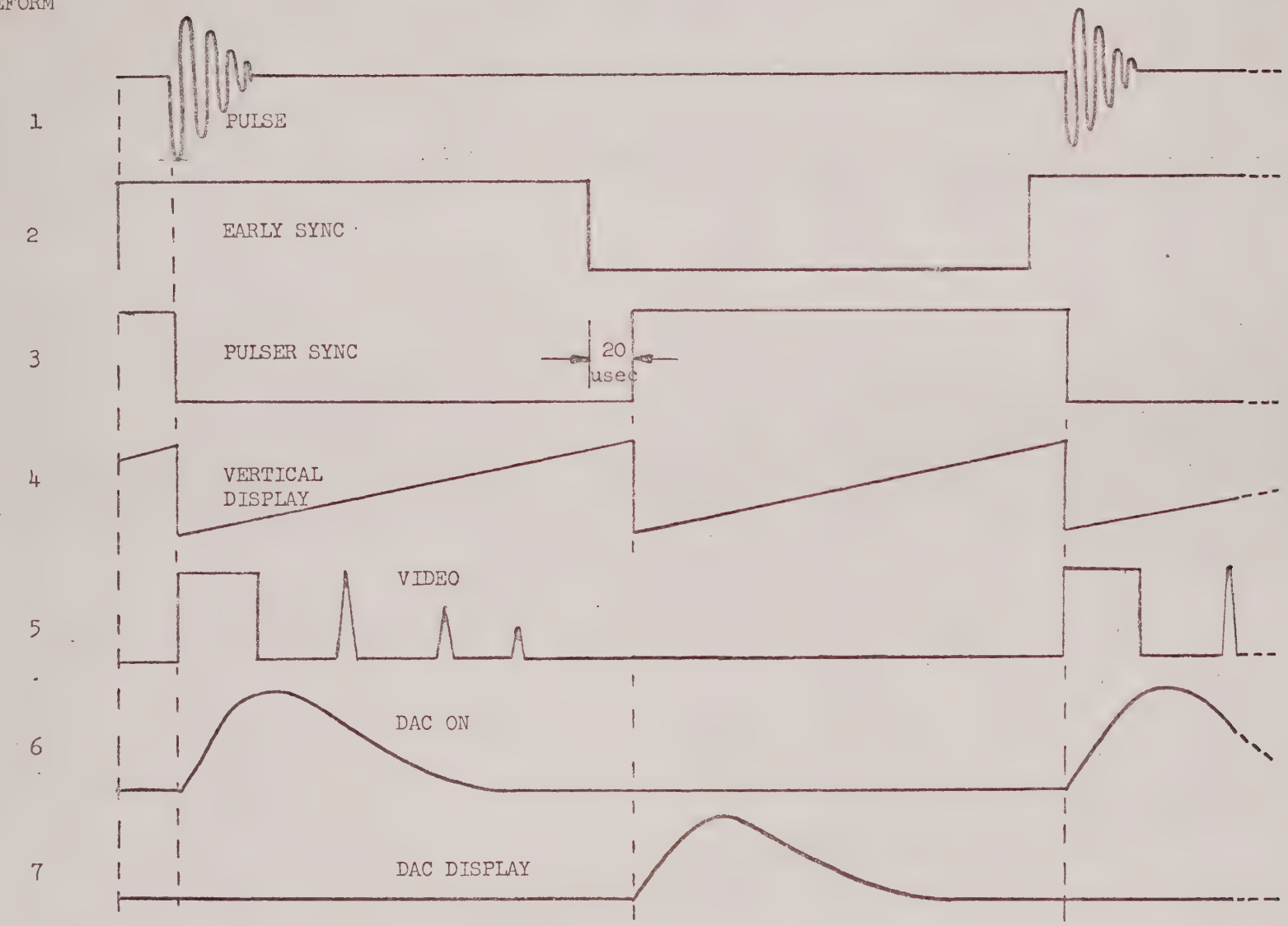


Figure 4- 8 Various Waveforms, Pulse, Sync, Vert. Display, Video and DAC

Waveform 6 and 7 - When a distance amplitude correction (DAC) circuit is incorporated in a Pulser/Receiver unit, these two waveforms are displayed on the CRT. Marker or step inputs are also displayed on the CRT.

All operating voltages for the Vertical Deflection amplifier are obtained from the low voltage power supply board.

4.3.4 Interconnection Printed Circuit Board Assembly 50C1370 (See Reference Schematic 50E618).

The purpose of the Interconnect Board is to Tie-in all signals and voltages from the Low Voltage Board, High Voltage Board, Deflection Amplifier Board and Plug-in Circuits (Pulser/Receiver and accessory) to present a display on the Cathode Ray Tube.

The output of the Low Voltage power supply is connected to J201 of the Interconnect Board. The voltages within this board are then distributed to the High Voltage Board, Deflection Amplifier Board, J101, J103, J105 and J106.

CHAPTER 5

MAINTENANCE

5.1 GENERAL

This chapter contains information for use in preventive maintenance, repair, and/or troubleshooting of the UM-771/775 Reflectoscope. There are Troubleshooting and Voltage charts. There are also five (5) photographs at the back section of this chapter which illustrate the UM-771/775 Reflectoscope with covers removed pointing out various components. These figures will be referenced throughout this chapter in connection with various maintenance procedures.

5.2 PREVENTIVE MAINTENANCE

Preventive maintenance consists of cleaning, visual inspection, lubrication, and recalibration. Preventive maintenance performed on a regular basis will help prevent instrument failure and will improve the reliability of this instrument. The severity of the environment which the Reflectoscope is subjected to will determine the frequency of maintenance.

5.2.1 Cleaning the Reflectoscope

The Reflectoscope should be cleaned as often as operating conditions require. Accumulation of dirt in the instrument can cause overheating and component breakdown. Dirt on components acts as an insulating blanket and prevents efficient heat dissipation. It also provides and electrical conduction path. The Reflectoscope covers provide protection against dust in the interior of the instrument. Operation without the covers in place will require more frequent cleaning and creates an electrical hazard.

5.2.1.1 Exterior

Loose dust accumulated on the outside of the Reflectoscope can be removed with a soft cloth or small paint brush. The paint is particularly useful for dislodging dirt on and around the controls. Dirt which remains can be removed with a soft cloth dampened in a mild solution of water and detergent.

CAUTION

Do not use any abrasive or solvent on the face of the CRT. Clean the CRT face with a soft, lint-free cloth dampened with denatured alcohol.

5.2.1.2 Air Filter

If air filter becomes dirty, remove and clean filter box with mild soap solution and warm water. After filter box has been dried out, spray a thin coat of Rotron Filtercoat on the outside of the filter box.

5.2.1.3 Interior

Dust in the interior of the instrument should be removed occasionally due to its electrical conductivity under high humidity conditions. The best way to clean the interior is to blow off the accumulated dust with dry, low-velocity air. Remove any dirt which remains with a soft paint brush or a cloth dampened with a mild water and detergent solution. A cotton-tipped applicator is useful for cleaning in narrow spaced or printed circuit.

5.2.2 Lubrication

The reliability of potentiometers, rotary switches and other moving parts can be increased if they are kept properly lubricated. Use a cleaning-type lubricant on shaft bushings, interconnecting plug contacts, and switch contacts. Lubricate switch detents with a heavier grease.

5.2.2.1 Lubrication of the Air Fan

a. The Mark 4 Muffin Fan has been oiled at the factor to provide ten years of operation at room temperature. If you intend to use your Mark 4 Muffin in ambient temperatures that exceed room temperatures, it is recommended to plan a re-oiling schedule for at least one oiling per year. Special oil and applicators are available as accessory items from Automation Industries, Inc., Sperry Division, Danbury, Connecticut, U.S.A.

    1. Rotron Part No. 19263, Oiler Kit
    2. Rotron Part No. 19263-4, Oiler Kit Refill Bottles

b. To inject oil into the bearing:

    1. Position the needle at an angle of 45° to the rubber dust cap located at the center of the motor spider.

    2. Pierce the rubber dust cap.

    3. Depress plunger firmly unitl oil has gone down one calibration line.

4. Hold the dust cap in position and withdraw needle and wipe off excess oil. Oil may be left in the syringe for future use. Be sure that the rubber dust cap remains in place after oiling.

5.2.3 Visual Inspection

The unit should be inspected occasionally for such defects as broken connections, improperly seated transistors, and heat damaged parts.

The remedy for most visible defects is obvious; however, particular care must be taken if heat-damaged parts are located. Overheating is usually only a symptom of trouble. For this reason, it is essential to determine the actual cause of overheating befor the heat-damaged parts are replaced; otherwise, the damage may be repeated.

5.3 CHECKOUT, ADJUSTMENT AND CALIBRATION

5.3.1 Power Supply Checkout and Adjustment (See Figure 5-2)

The schematic diagram (50E618) shows the voltage readings which should be obtained at the various power-supply test points. The schematic diagram shows where the voltage test points are physically located. Use "E" numbers on the PC Board to check voltages.

WARNING

Be extremely careful in making measurements with the supply turned on. Voltages dangerous to life are present.

If it becomes necessary to replace any power supply components, the output of the power supply may have to be readjusted. Use the following procedure to insure that the supply is working properly after repair.

a. Turn the power on and set the front-panel sweep timing and display controls for normal sweep presentation.

b. Test Equipment

1. Tektronix 531 with 2 channel plug-in or equivalent.

2. RCA Senior Voltohmest WV-87A, Simpson 270 or equivalent.

CAUTION

Lethal voltages are present; always turn instrument "off" when making temporary connection. Always keep one hand clear when measuring and adjusting controls. Do not touch any of the components or wiring. Ground all instruments and test equipment.

5.3.1.1 Low Voltage Power Supply Checks and Adjustments P.C. Board Number 50D568 (See Figure 5-2)

Remove top and bottom covers of the UM-771/775 Reflectoscope.

NOTE

Do not adjust voltage controls if output voltages fall within stated tolerances. Use insulated screwdriver whenever possible.

a. Plus 300 Volt Power Supply

1. Check cathode voltage at CR205 and ground. It should read between 225 volts and 270 volts.

2. Check +300 volt power supply at E15 and ground. The voltage should read +300V ±5 volts. Adjust R204 if necessary.

3. Measure with an oscilloscope the peak to peak ripple voltage at E15; it should be no greater than 50MV.

b. Plus 150 Volt Power Supply.

1. Check cathode voltage at CR214 and ground. It should be between +110V and +120V.

2. Check +150 volt Power Supply at E18 and ground. The voltage should read +150V ±1.5V. Adjust R209 if necessary.

3. Measure with an oscilloscope the peak to peak ripple voltage at E18; it should be no greater than 25MV.

c. Minus 108 Volt Power Supply

1. Check voltage from anode CR222 to cathode of CR221. Reading should be between 74 and 82 volts.

2. Check anode voltage of CR222 and ground. The voltage should read -108V ±2V. Adjust R124 if necessary.

3. Measure with an oscilloscope the peak to peak ripple voltage at E34 and ground. It should be no greater than 15MV.

d. Plus 75 Volt Power Supply

1. Check +75 power supply at E24 and ground. The voltage reading should be between +69V and 77V. No adjustment is available for the +75V.

2. Measure with an oscilloscope the peak to peak ripple voltage at E24 and ground; it should be no greater than 50MV.

e. Plus 12 Volt Power Supply

1. Check +12 volt power supply or E27 and ground. The voltage reading should be +12V +1V. Adjust R220 if necessary.

2. Measure with an oscilloscope the peak to peak ripple voltage at E27 and ground; it should be no greater than 3MV.

f. Minus 12 Volt Power Supply

1. Check -12 volt power supply at E30 and ground. The voltage reading should be -12V $\pm$.1V. Adjust R225 if necessary.

2. Measure with an oscilloscope the peak to peak ripple voltage at E30 and ground; it should be no greater than 3MV.

TABLE 5-1

Summary of the Low Voltage Power Supply

Voltage	Test Point	Adjust	Ripple less than
+300+3V	E15 & Grd.	R204	50MV
+150V$\pm$1.5V	E18 & Grd.	R209	25MV
-108V$\pm$2V	E21 & Grd.	R214	15MV
+75V($\pm$3,-6V)	E24 & Grd.	None	50MV
+12V$\pm$.1V	E27 & Grd.	R220	3MV
-12V$\pm$.1V	E30 & Grd.	R225	3MV

5.3.1.2 High Voltage Power Supply, CRT Checks and Adjustments
P.C. Board Assembly 50D573 (See Figure 5-3)

CAUTION

High Voltages are present. Do not touch any of the components or wiring. Always keep one hand in the clear when making adjustments and temporary connections (connecting test lead, etc.).

a. Check if intensity and focus of the CRT Sweep presentation are within specifications:

   1. Vary Intensity control between upper and lower limit. The intensity should extinguish and come in to full brilliance.

   2. Check CRT focus; the entire sweep should remain within focus.

b. If the preceeding steps (1 and 2) are not within specification, perform the following high voltage adjustment steps (c through j).

c. With the power in the OFF position, remove Q307. By removing Q307, the high voltage circuit is inoperative, low voltage operative.

d. Apply power. Observe that VR301 thru VR304 SHOULD NOT BE LIT. If regulator tubes are lit high voltage is present. Remedy high voltage problem before proceeding to the below steps.

e. Measure the plate (red dot) of VR305; it should read +164V ±5V.

f. Measure cathode of CR304; it should be 2V ±.5V.

g. Measure the plate voltage of VR 308 with the scope. This should be a 105V ±10V unblanking signal at this point. The low point of the unblanking signal should be variable from +37V +5V to +120V ±10V measured by adjusting the intensity control R312.

h. Remove power, reinsert transistor, Q307, apply power.

CAUTION

High voltage should be present. Always keep one hand in the clear when making measurements or adjustments.

i. Check if tubes VR301, thru VR304, are energized (lit).

j. Rotate intensity control to the fully clockwise position. Observe CRT trace of maximum brightness.

CAUTION

DO NOT measure between cathode and Pin 3 of P302. Damage could result to the CRT when test instrument is connected. In doing so, a very high intensity signal could be displayed on the CRT.

k. Measure with the RCA Senior VTVM or equivalent the high voltage reading should be +4.1KV ±200V.

l. Measure cathode VR309. Reading should be -1900V (+50V, -200V).

m. Measure E12 and ground, reading should be -1625V ±85V.

n. Adjust for proper geometry. Geometry is a rectangular roster centered on the face of the tube. The roster edges will not deviate from straight lines on the left and right edges or top and bottom of the CRT.

o. Adjust focus control for the sharpest presentation over entire sweep range.

p. Adjust astigmatism control for proper astigmatism. Sweep line should remain in focus over entire sweep length.

q. Repeat steps o and p for the best results.

r. Observe sweep trace on CRT, rotate intensity control (upper and lower limit). Sweep trace should turn on and off.

s. Disconnect all test leads and normalize instrument.

5.3 Horizontal and Vertical Deflection Amplifiers and Timesharing Circuits. P.C. Board Assembly 50D569.

5.3.1 The following Table 5-2 lists the proper signal levels for the Horizontal and Vertical Amplifier inputs.

TABLE 5-2

Horizontal and Vertical Amplifier Inputs

Test point	Signal	Function
E5	-12V	Supply
E6	6.7V P-P/Vert Aux Input	Video Signal
E7	+150V	Supply
E8	6.7 P-P	Video Signal
E11	0V	Gates Input
E12	Grd	Grd
E13	+12/-12 Square Wave	Early Sync
E15	+12V	Supply
E19	6.7V P-P/Vert Aux Input	Time Shared Output
E21	5V P-P (Sawtooth)	Final Horizontal Input
E25	+75V	Supply
J402	Variable from	
B	-.5 to +4V	Horizontal Position
U	+.5 to +8V	Vert Aux Input
T	-1 to +8V	Vert Positioning

5.3.2 Horizontal and Veritcal amplifier adjustments and checks (See Figure 5-4).

a. Check the current on the +75 Volt line. Adjust if necessary R450 (vertical sync bias) for 88 ma. This is a FACTORY ADJUSTMENT.

b. Check the current on the 150 volt line. Adjust if necessary R403 (Horizontal sync bias for 28 ma. This is a FACTORY ADJUSTMENT.

c. Adjust the horizontal gain control R402 to give full screen deflection. Make sure the horizontal positioning is properly adjusted and able to center the horizontal deflection.

d. Adjust the vertical gain control R443 to give 3" vertical deflection. Make sure the vertical positioning control is properly adjusted and able to center the vertical deflection.

e. Check to see the positioning control for vertical aux. input positions alternate trace.

f. Measure the voltage on J404. Adjust R411. Make sure this control can vary the voltage on J404 from -12V to +12V.

g. Disconnect all leads and normalize instrument.

5.4 TROUBLESHOOTING

5.4.1 Troubleshooting is the process by which the cause of a malfunction is discovered by means of a systematic procedure. Most malfunctions which will occur in the UM-771/775 Reflectoscope will be electrical in nature. First, a thorough knowledge and understanding of the Reflectoscope instrument is a prerequisite. Second, suspected malfunctions such as: intensity is set to low or a switch is in the wrong place.

5.4.2 The following will help to localize a particular trouble to a single assembly:

a. Troubleshooting Charts (5-1 thru 5-12)

b. Voltage Charts (5-13 and 5-14)

c. Photographs (Figure 5-1 thru 5-5 Component Identification)

WARNING

Never connect or disconnect Transistor Plug-in units or P.C. Boards when UM Reflectoscope is in the "ON" position.

Always begin troubleshooting by making a visual inspection of the four P.C. Boards and associated circuits. Check for any loose or burned components. Check for any loose wire connection, connectors not mating correctly, and any other related source of trouble. If the particular trouble can not be localized, replace the three printed board assemblies, by process of illimination.

CAUTION

Avoid shorting supply voltage or components when measuring voltages or waveforms.

5.4.3 Test and Associated Equipment

The following test and associated equipment is required for checking the Reflectoscope.

a. Servistension Style 50C549.

b. Tektronix 531 or equivalent recently calibrated.

c. Simpson Model 260, recently calibrated. High Voltage probe.

CAUTION

Personal Safety Warning. Lethal Voltages are present. Always turn instrument OFF when changing components. Always keep one hand in the clear when making temporary connections (connecting test leads, etc.).

5.4.4 All electrical components are accessible for replacement from the P.C. Boards and sub-assembly. The Low Voltage and the High Voltage P.C. Board assemblies are hinged and swing up in position for easier maintenance. (See figure 5-1)

The instrument P.C. boards are double etched circuit boards and electrical components ate hole-through mounted. Before the component is removed from the P.C. board special consideration should be followed:

a. Use low heat soldering iron (35 to 55 watts and less than 700°F usable temperature).

b. Small diameter solder (60/40). Clean the surrounding area thoroughly after Rosin solder is used.

NOTE

Do not use Acid core solder.

c. Care should be taken to avoid damage to the circuit board by applying too much heat or solder. Avoid ripping the printed board conducter leads.

d. If small diodes are to be removed at reinstalled use a heat sink between the soldering iron and the component lead.

e. If the component is burnt, chip off the leads, flush to the P.C. board and remove unclipped leads from opposite side of P.C. board.

f. Clear solder hole on the P.C. board.

g. Reinstall component leads and clip to proper length.

h. Resolder component again avoiding excess heat.

CHART 5-1 NO SPOT OR SWEEP ON CRT (Maximum intensity - vary vertical unblanking check and horizontal positioning)

Check Input AC Power Fuses F101 and F102 and ON-OFF Switch

(Light should energize on the ON-OFF switch)

CRT filament not lighted

Remove Q305 (High Voltage Supply) Check 6.3V term 1 and 3 of T101

CAUTION: HI VOLTAGE

If 6.3V is present, check CRT filament Pins 1 and 14. (Remove CRT Socket)

Check +4.1KV and lead connection

Check -12V, +300 and +150V. Low or Absent on High Voltage P.C. Bd.

Check Low and High Voltage power supply.

Unblanking Check E2

Pin #2 R312 Intensity Control +120 ±10V

Check if VR301 thru VR304 are Lighted

CHART 5-2 SWEEP CANNOT BE FOCUSED

- Check that astigmatism control is functioning
  - Check +300 at R324 (Astig. Control)
    - Check Low Power Supply
- Intensity control set too high (R332)
  - Check -1900 volts and +4.1KV
    - CRT possibly defective gassy CRT
- Determine that focus control, R317 is functioning

CHART 5-3 SWEEP TOO DIM (Maximum Intensity) Proper Focusing

- Check +4.1KV and -1900 volts
  - With Q304 removed check 6.3 filament voltage of CRT (Terminals 1 and 3) T101
    - CRT may be defective
- Check unblanking waveforms

CAUTION HIGH VOLTAGE

CHART 5-4 LOW OR NO +300 VOLTS

- Check fuse F201
- Check voltage at E1 and E2. Voltage should be 306VAC
  - Check voltage at E40 and ground should be +300VAC
    - Check Q101
- Unable to adjust +300V Check Q202 and Q201
  - Check Zener Diodes CR205 thru CR209

CHART 5-5 LOW OR NO +150 VOLTS

- Check fuse F202
- Check voltage at E3 and E4. Voltage should be 158VAC.
  - Check voltage at E32 and ground should be +150V
    - Check Q102
- Unable to adjust +150V. Check Q204 and Q203.
  - Check Zener Diodes CR214 thru CR216

CHART 5-6 LOW OR NO -108 VOLTS

- Check Fuse F203
- Check voltage at E5 and E6. Should be 117VAC
  - Check voltage at E34 and ground should be -108V
    - Check Q103
- Unable to adjust -108V. Check Q205 and Q206
  - Check Zener Diode CR221 and CR222

CHART 5-7 LOW OR NO +75 VOLTS

- Check Fuse F204
- Check voltage at E7 and E8. Should be 86VAC.
  - Check voltage at E33 and ground should be +75V.
- Check Q104 and Q207
  - Check Zener Diode CR227.

CHART 5-8 — LOW OR NO +12V (No Adjust)

- Check F205
- Check voltage at E9 and E11. Should be 34VAC
  - Check voltage at E35 and ground should be +12VDC
    - Check Q105.
- Unable to Adjust 112V Check Q213, Q208 & Q209.
  - Check Q210 & Q211

CHART 5-9 — LOW OR NO -12V (No Adjust)

- Check F206
- Check voltage at E9 and E11. Should be 34VAC.
  - Check voltage at E37 and ground should be -12VDC
    - Check Q106
- Unable to adjust -12V. Check Q215, Q216 & Q217.
  - Check Q212 & Q214

CHART 5-10 — NO +4100V OR -1580V

- Check low voltage -12V, +150V & +300V
  - Check inve ter Q301 and Q302.
    - Check unblanking input at E2 on the Hi Voltage Bd.
- No +4.1KV
  - Check T301
    - Check Hi Voltage Diodes CR302 and CR301
- No -1580 at E12 on Hi Voltage Bd.
  - Check if VR301 thru VR304 are lit.
    - Check Q305
      - Check Hi Voltage Diode CR303

CHART 5-11

VERTICAL LINE* OR
HALF THE HORIZONTAL DEFLECTION ON CRT**

- Check Final Horiz. Input Waveform at J402-X*
  - Defective Transistors Q404 or Q403*
    - Check Q405*
- Horiz. Gain R402 out of adjustment**
  - Check +150V** Power Supply
- Defective Q401 or Q402**

CHART 5-12

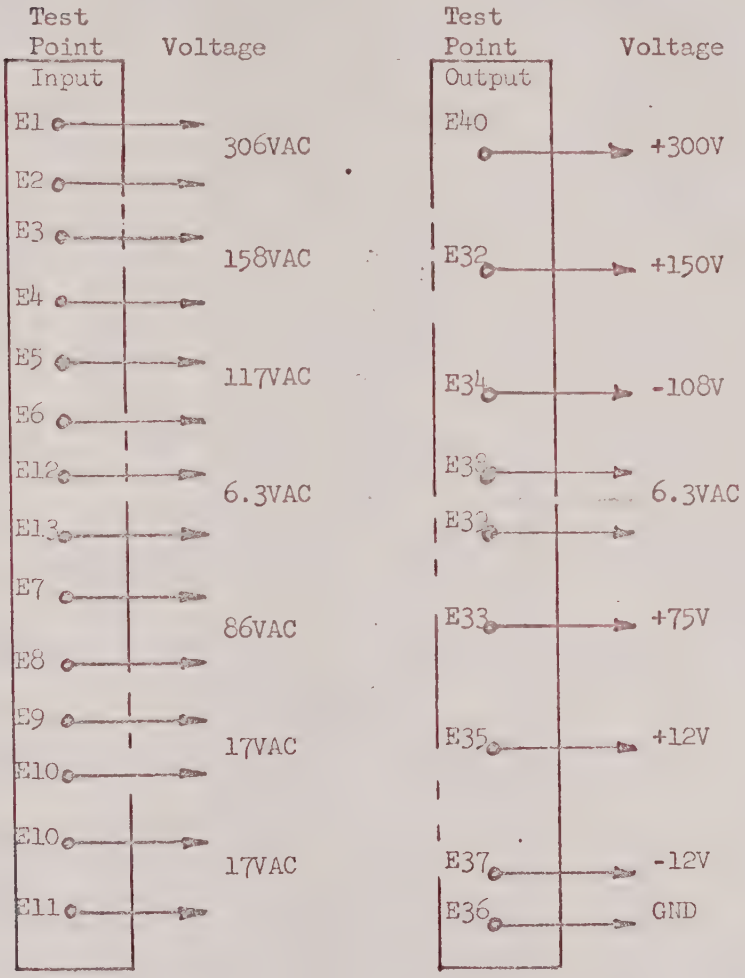
HORIZONTAL LINE* OR
HALF THE VERTICAL DEFLECTION ON CRT**

- Check Final Vert. Input Waveform at J401-6*
  - Deflective Amp Q406 Q407, Q408 or Q409*
    - Check Q413*
- Vert. Gain R443 out of Adjustment**
  - Check +75V** Power Supply
- Defective Q411, or Q412**

VOLTAGE CHARTS

CHART 5-13

Low Voltage Power Supply Board No. 50D568



NOTE

1. Use Simpson Model 360 or equivalent and Hi Voltage probe.
2. Voltage measurements are made with respect to the DC power supply ground.

CAUTION

Personal Safety Warning: Lethal Voltages are present.

CHART 5-14

High Voltage Power Supply and Unblanking Board No. 50D573

Test Point	Voltage
E3	-12V
E4	+150V
E5	+4,100V
E8	-1580V (Approx.) (Caution: Do not measure)
E9	-1300V
E10	+300V (Approx.)
E13	+300VDC (Approx.)
E19	+300V

Deflection Amp. Board No. 50D569

Test Point	Voltage
E1	6.3VAC
E2	
E5	-12V
E7	+150V
E12	GND
E15	+12V
E25	+75V

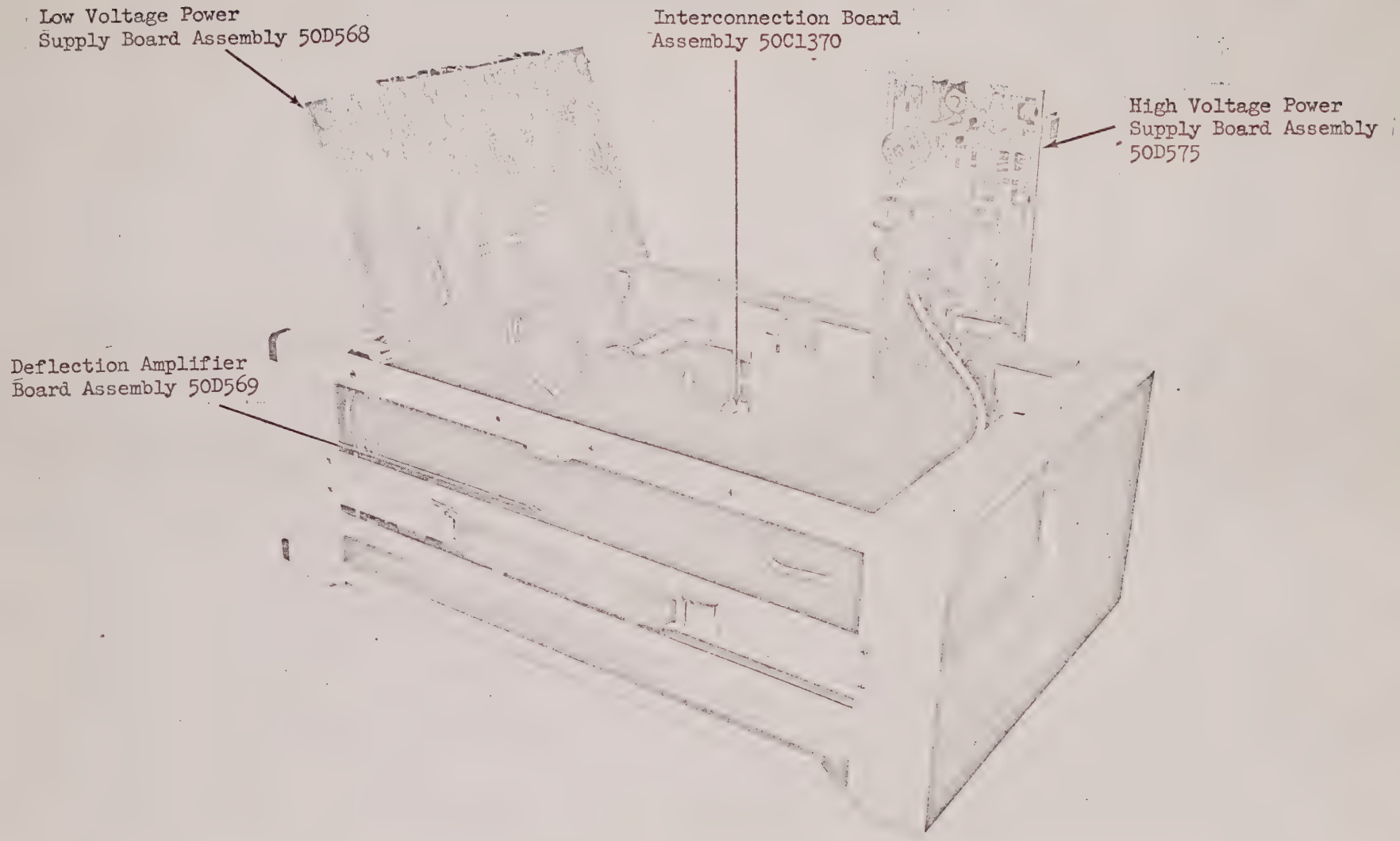


Figure 5-1 The UM-775 is illustrated with the covers removed, showing various P.C. Board Assembly Locations. The P.C. Board Assembly Locations for the UM-771 are the same as in the UM-775 Reflectoscope.

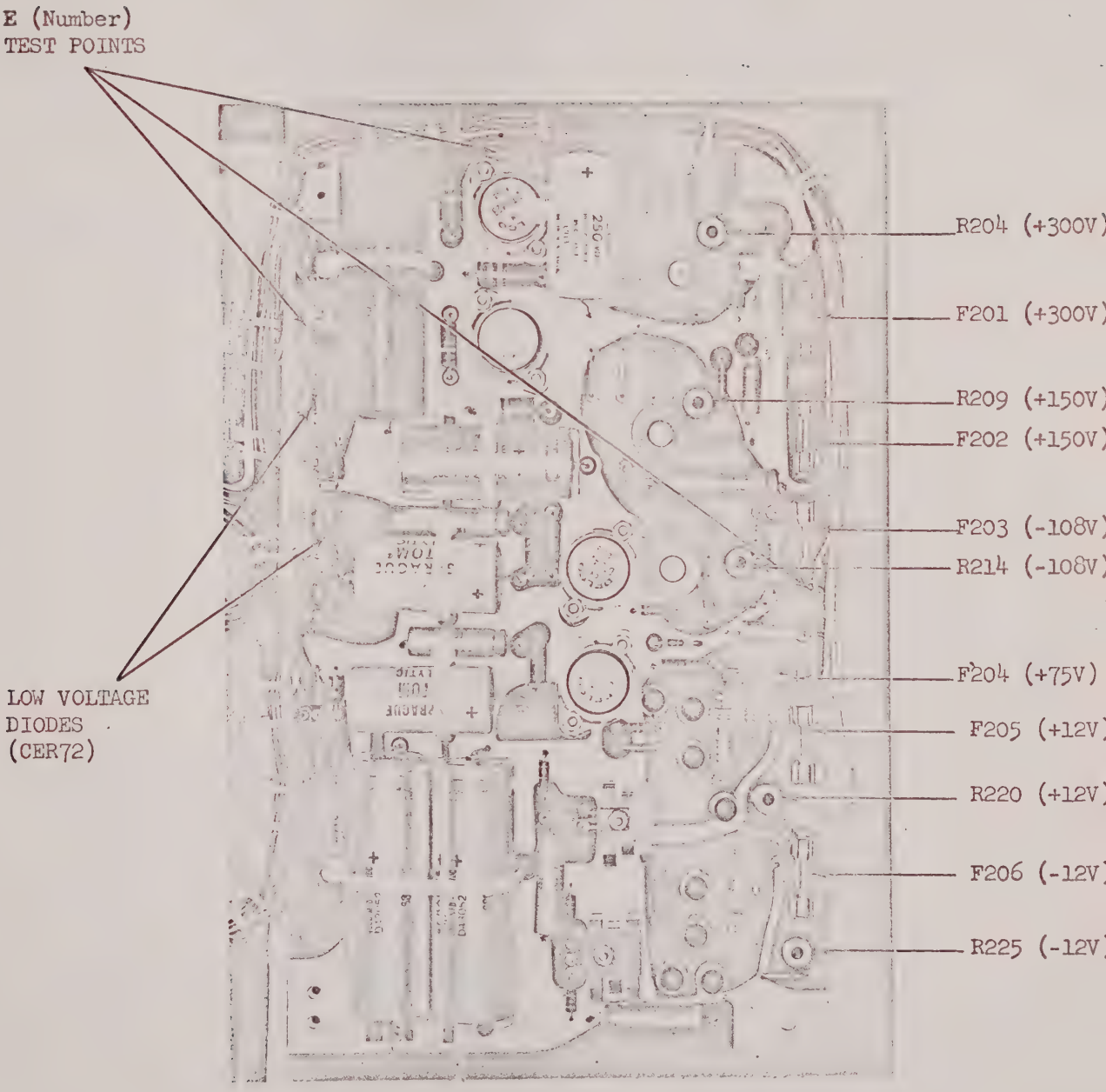


Figure 5-2 Various Components and Test Points in the Low Voltage Power Supply Board Ass'y 50D568

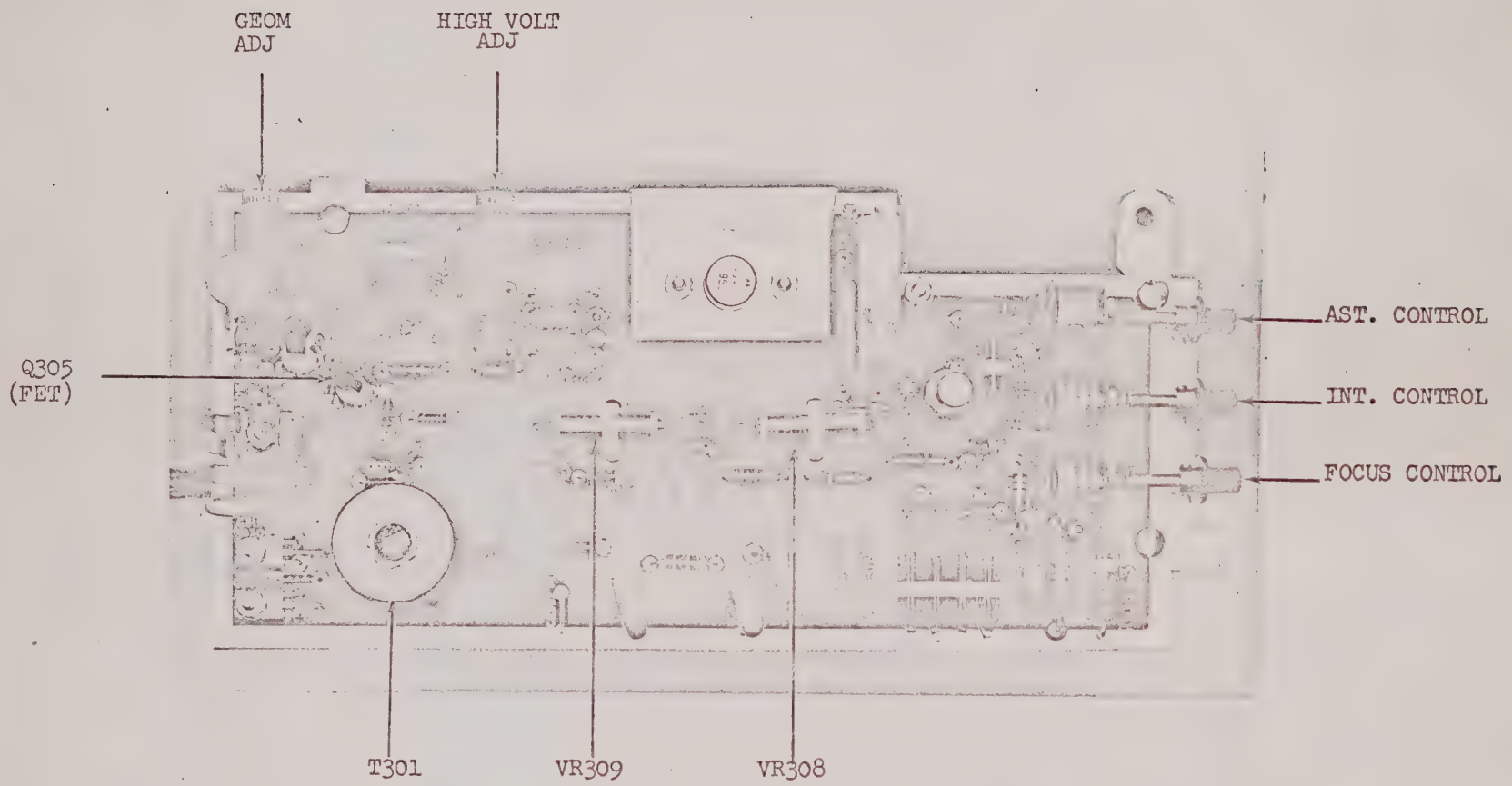


Figure 5-3 Various Components in the High Voltage Power Supply and Unblanking Board Ass'y 50D575 .

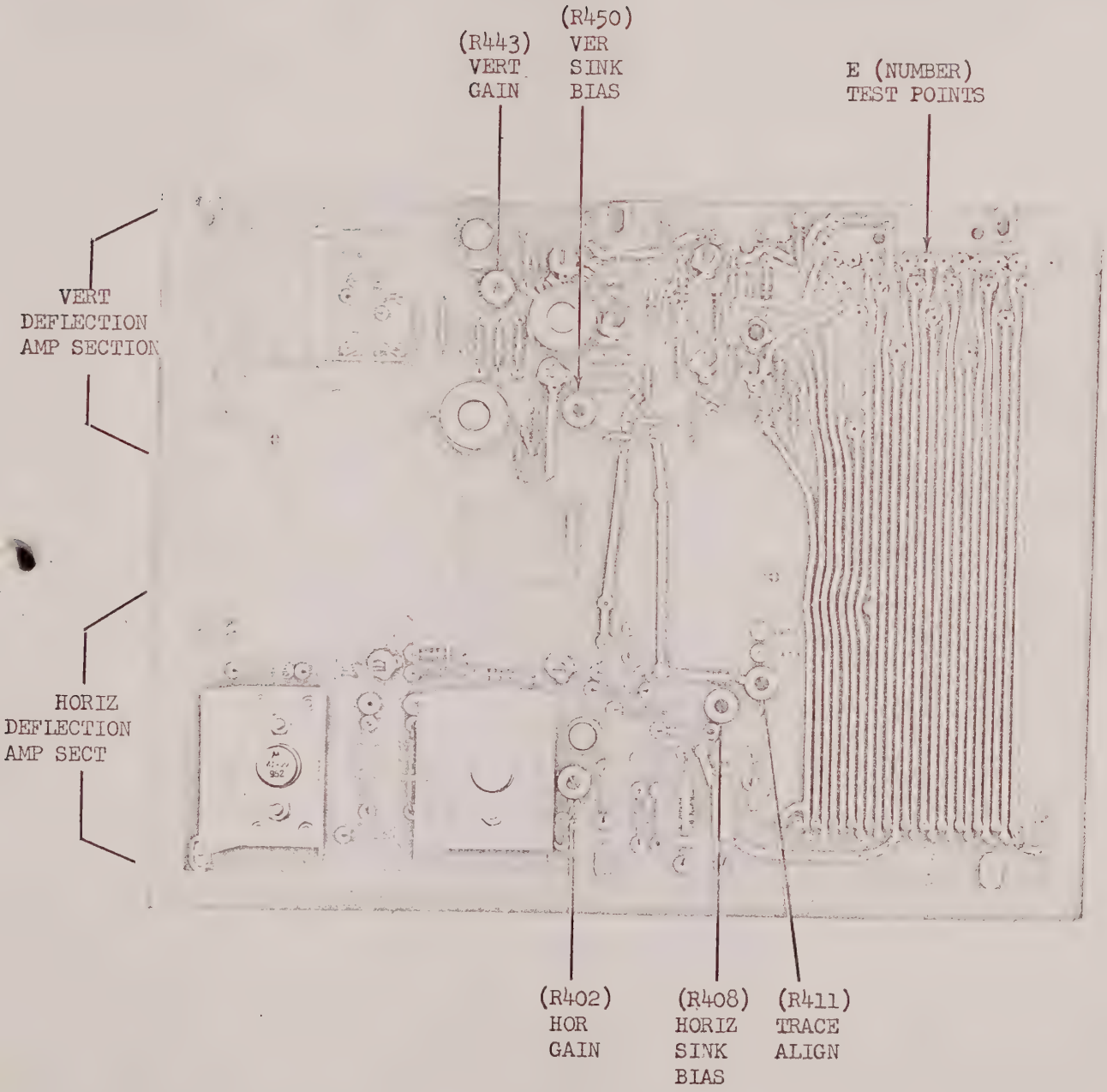


Figure 5-4 Various Components and Test Points in the Deflection Amplifier Board Ass'y 50D569

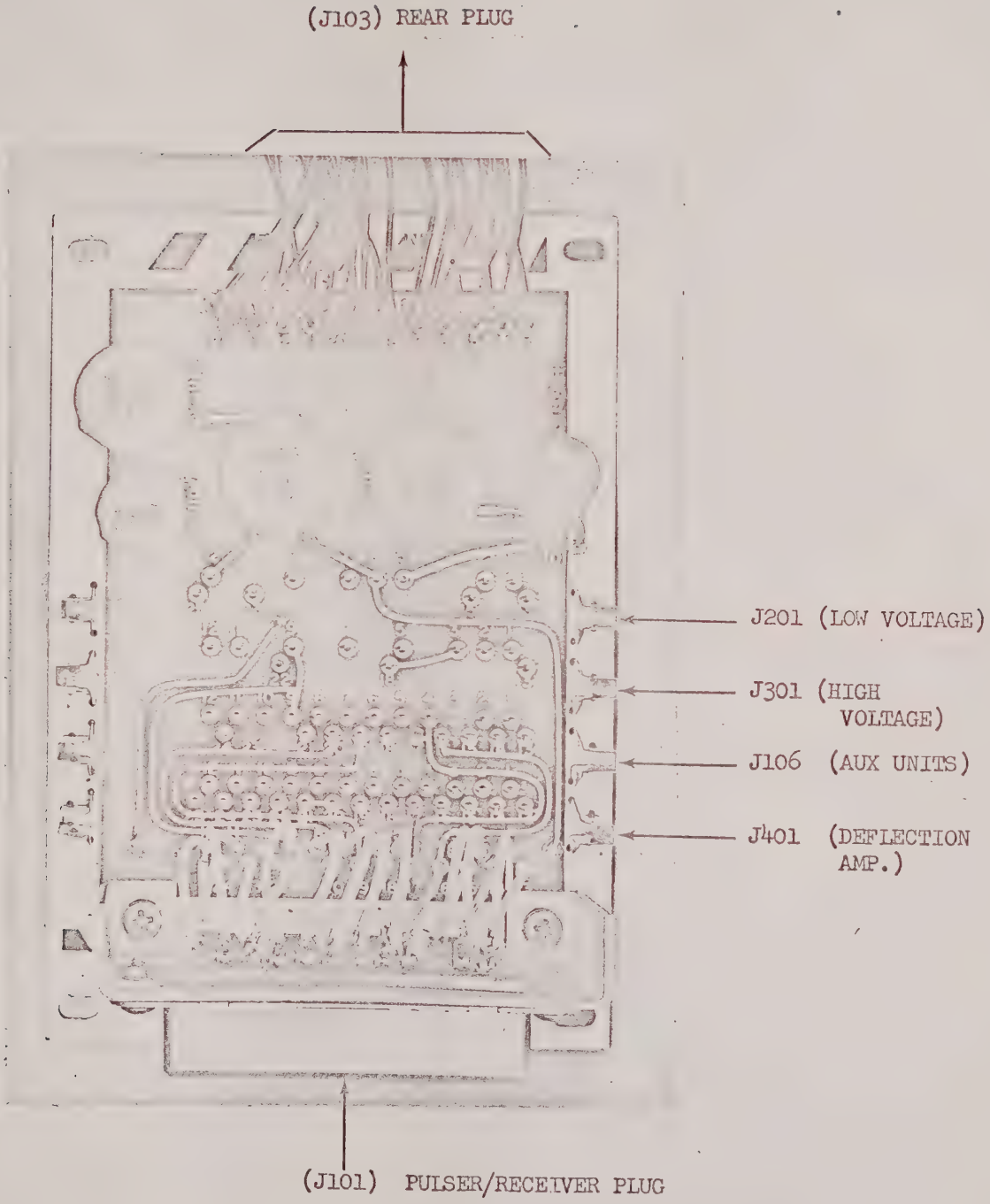
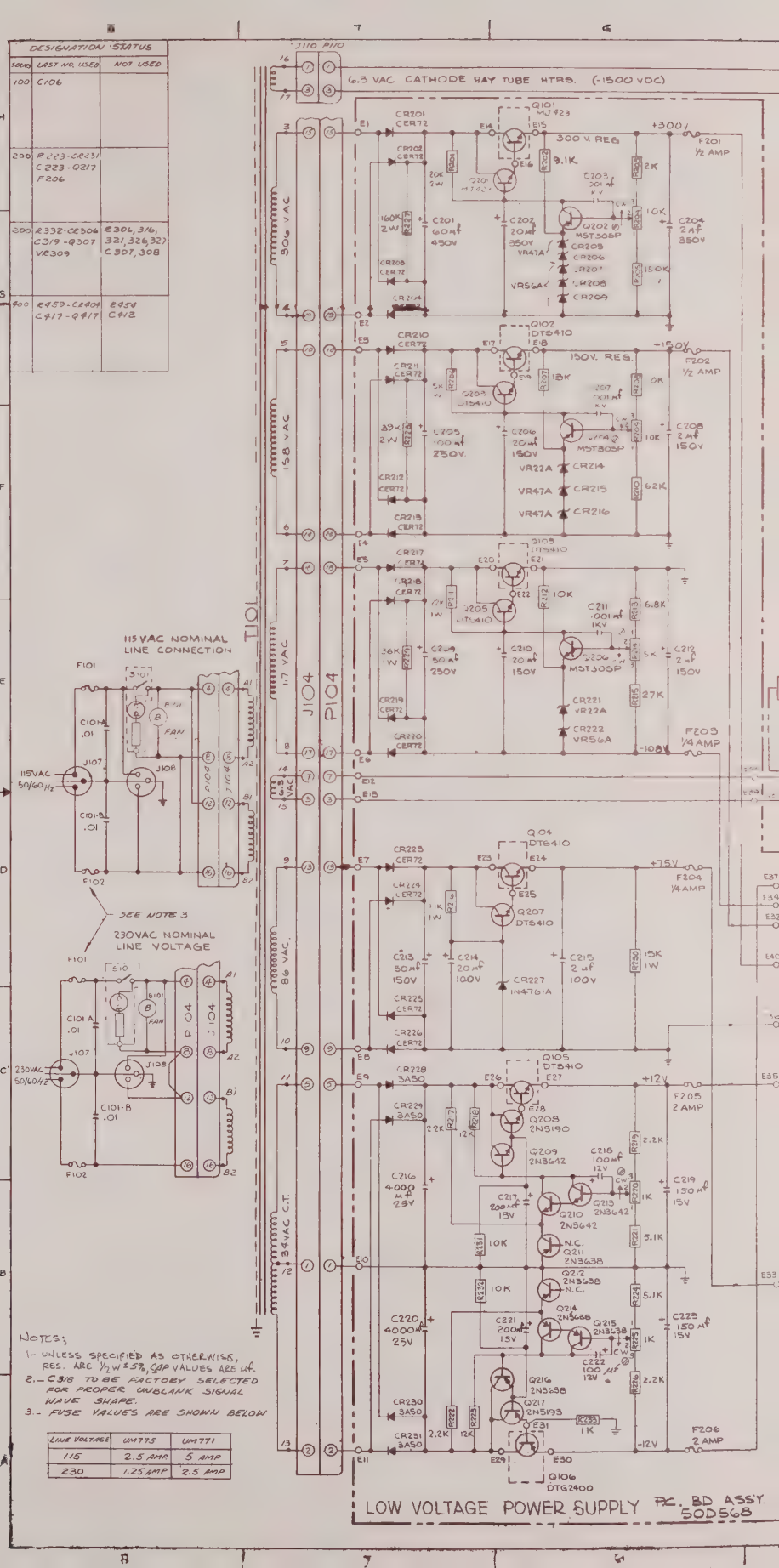
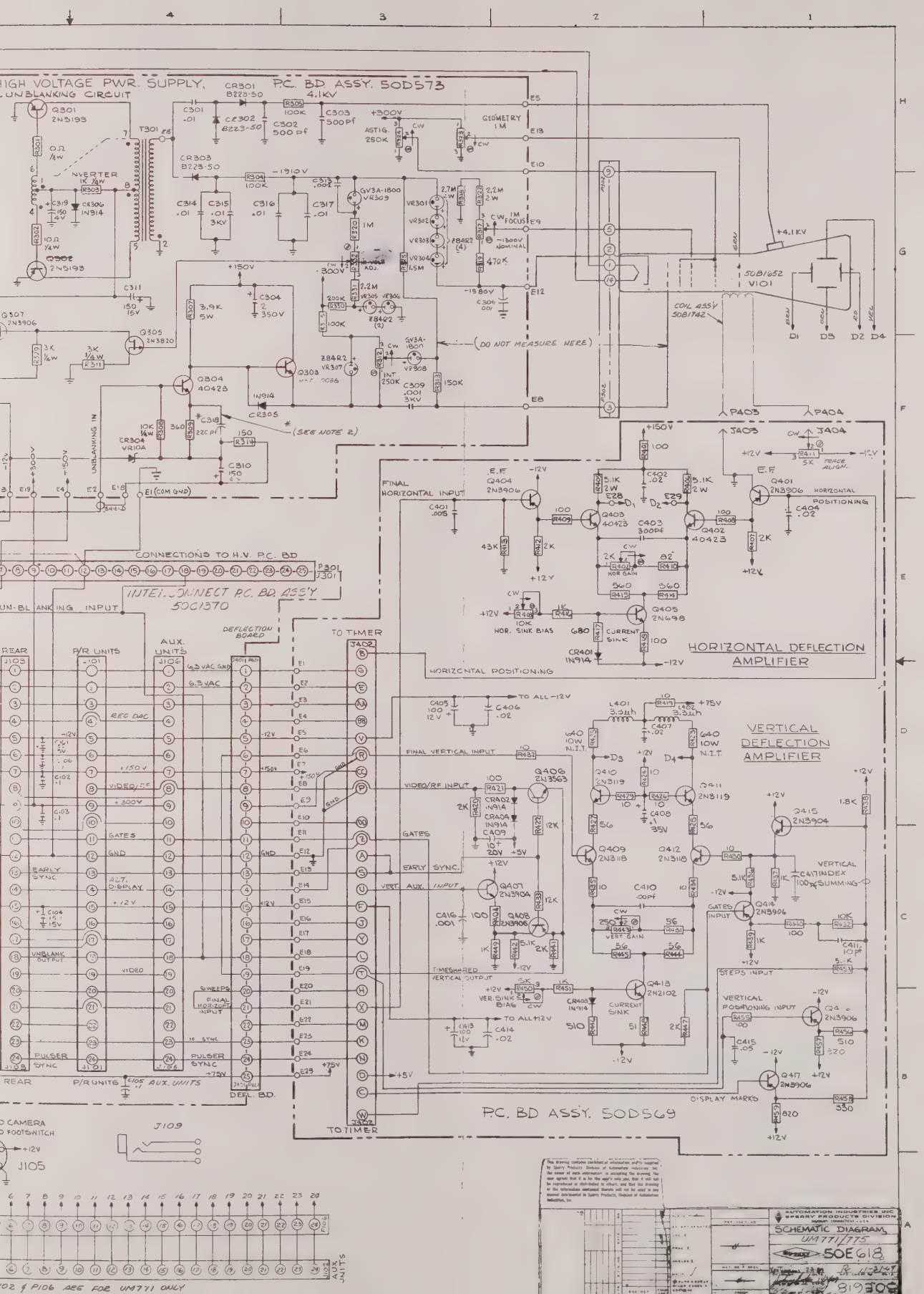


Figure 5-5 Various Components and Test Points in the Interconnect Board Ass'y·50C1370


DESIGNATION STATUS
LAST NO. USED
NOT USED
100 C106
200 F223-CR231 C223-Q217 R206
300 R332-CR304 C3/9-Q307 VR309
E306, 316, 321, 326, 327 C307, 308
400 R359-CR404 C417-Q417
R358 C412
J110 P110
6.3 VAC CATHODE RAY TUBE HTRS. (-1500 VDC)
506 VAC
158 VAC
17 VAC
86 VAC
34 VAC C.T.
J104 P104
T101
300 V. REG
150V. REG.
+300V
+150V
+75V
+12V
-12V
-100V
F201 1/2 AMP
F202 1/2 AMP
F203 1/4 AMP
F204 1/4 AMP
F205 2 AMP
F206 2 AMP
Q101 MJ423
Q102 IDTS410
Q103 MST305P
Q104 DTS410
Q105 DTS410
Q106 DTG2400
Q201 MJ423
Q202 MST305P
Q203 DTS410
Q204 MST305P
Q205 DTS410
Q206 MST305P
Q207 DTS410
Q208 2N5190
Q209 2N3642
Q210 2N3642
Q211 N.C. 2N3638
Q212 N.C. 2N3638
Q213 2N3642
Q214 2N3638
Q215 2N3638
Q216 2N3638
Q217 2N5193
115 VAC NOMINAL LINE CONNECTION
230VAC NOMINAL LINE VOLTAGE
SEE NOTE 3
FAN
J107
J108
F101
F102
S101
C101-A .01
C101-B .01
NOTES:
1- UNLESS SPECIFIED AS OTHERWISE, RES. ARE 1/2W ±5%, CAP VALUES ARE µf.
2.- C3/8 TO BE FACTORY SELECTED FOR PROPER UNBLANK SIGNAL WAVE SHAPE.
3.- FUSE VALUES ARE SHOWN BELOW
LINE VOLTAGE
UM775
UM771
115
2.5 AMP
5 AMP
230
1.25 AMP
2.5 AMP
LOW VOLTAGE POWER SUPPLY PC. BD ASSY. 50D568


HIGH VOLTAGE PWR. SUPPLY, CR301 B229-50 P.C. BD. ASSY. 50D573
& UNBLANKING CIRCUIT 4.1KV
Q301 2N5193
T301
INVERTER
Q302 2N5193
CR303 B223-50
-1910 V
GV3A-1800 VR309
VR301
VR302
VR303
VR304
Z8422 (4)
-1800V NOMINAL
+4.1KV
50B1652 V101
COIL ASSY 50B1742
D1 D3 D2 D4
(DO NOT MEASURE HERE)
+150V
-300V
-1580V
Q307 2N3906
Q305 2N3820
Q303 Z8422 (2)
Q304 40423
CR305
CR304 VR10A
(SEE NOTE 2)
UNBLANKING IN
E1 (COM GND)
CONNECTIONS TO H.V. P.C. BD
P301 J301
INTERCONNECT P.C. BD. ASSY 50C1370
UNBLANKING INPUT
REAR P/R UNITS AUX. UNITS
DEFLECTION BOARD
TO TIMER
J102
J103
J105
J109
REC DAC
VIDEO/RF
GATES
GND
EARLY SYNC.
ALT. DISPLAY
+12V
UNBLANK OUTPUT
VIDEO
PULSER SYNC
+75V
SWEEPS
FINAL HORIZONTAL INPUT
DEFL. BD.
TO CAMERA
FOOTSWITCH
P.C. BD. ASSY. 50D569
FINAL HORIZONTAL INPUT
HORIZONTAL POSITIONING
HORIZONTAL DEFLECTION AMPLIFIER
HOR. SINK BIAS
CURRENT SINK
HOR GAIN
HORIZONTAL POSITIONING
TRACE ALIGN.
FINAL VERTICAL INPUT
VIDEO/RF INPUT
VERT. AUX. INPUT
TIMESHARED VERTICAL OUTPUT
VERT. SINK BIAS
VERT GAIN
VERTICAL DEFLECTION AMPLIFIER
VERTICAL INDEX SUMMING
STEPS INPUT
VERTICAL POSITIONING INPUT
DISPLAY MARKS
J403
J404
P403
P404
AUTOMATION INDUSTRIES INC. SPERRY PRODUCTS DIVISION
SCHEMATIC DIAGRAM
UM771/775
50E618
11-3-67

APPENDIX A

GLOSSARY

ACOUSTIC ATTENUATION	The loss of energy at an ultrasonic wave-front as it passes through a material. Usually measured in db/cm.
ACOUSTIC IMPEDANCE	The product of the density and the velocity of a material. An important factor governing the propagation of waves at material bounderies.
AMPLIFIER	Any circuit which increases the amplitude of an electronic signal.
AMPLITUDE	The height of a displayed signal. An indication of the amount of reflected energy.
ANGLE BEAM TESTING	Ultrasonic testing using a transducer oriented to the test surface at any angle other than perpendicular.
ANGLE OF INCIDENCE	That angle between the direction of the ultrasonic beam and a line perpendicular to the test material surface at the point of entry.
ASTIGMATISM CONTROL	Control for focusing the outer edges of the sweep on a cathode ray tube.
BACK SURFACE	That surface of the test material farthest from the transducer.
C.R.T. (CATHODE RAY TUBE)	Display tube in the UM Reflectoscope
COAX (COAXIAL CABLE)	A special type of electrical cable with one conductor inside of and insulated from the other.
COMPRESSIONAL WAVE	In ultrasonics, synonymous with longitudinal wave.
COUPLANT	A liquid or semi-liquid used in contact testing to facilitate the transmission of wave movement from the transducer face to the entry surface of the test material. Typically a couplant is water or an oil of some type.

CRITICAL ANGLES	The incident angles which produce complete mode conversion in a particular material.
CRYSTAL	The active element in an ultrasonic transducer. Usually a material with piezoelectric qualities.
DAC (DISTANCE AMPLITUDE CORRECTION)	The circuit which increases the gain of the receiver as time progresses (as the ultrasound penetrates deeper into the test material).
DAMPING MATERIAL	The material used in transducer construction to back the crystal. Its purpose is to reduce crystal ringing.
DEFLECTION PLATES	The vertical and horizontal electrodes within a cathode ray tube which produce the trace by moving the spot on the screen.
DELAYED SYNC	The synchronizing signal occurring at the time the sweep starts; the point of time at the left of the screen.
DISCONTINUITY	A general term applied to any interruption of an ultrasonic wave movement within a test material. Usually the term refers to a defect.
EARLY SYNC	The synchronizing signal generated first from which all other signals are timed; times zero.
FOCAL LENGTH	The distance between the transducer face and the focal point.
FOCAL POINT	The converging point of an ultrasonic beam. The point of maximum intensity.
FREQUENCY	The number of completed wave cycles per unit time.
FRONT SURFACE	That surface of the test material closer to the transducer.

GAIN	Amplification
GAIN CONTROL	Amplification control
INITIAL PULSE	The first signal displayed on the sweep. It represents the energy produced by the pulser and in contact testing may be coincident with the test surface reflection.
INTERFACE	The boundry between two closely proximate materials. In immersion testing the term is often used to identify the signal returned from the entry surface of the test material.
LONGITUDINAL MODE	A form of ultrasonic vibration wherein the particle motion within the test material is parallel to the direction of propagation.
LONGITUDINAL WAVES	Longitudinal waves are characterized by particle displacement in the direction of wave propagation. Also called compressional waves from the pattern of alternating particle compression and rare faction produced by the wave movement.
MAIN BANG	The transmitted pulse of ultrasounc.
MODE CONVERSION	The changing from one mode of wave propagation to another which is a function of the incident angle and the material velocity.
PIEZOELECTRIC EFFECT	The expansion and contraction of certain materials when activated with a voltage, or the eliciting of a voltage in the same material by mechanical strain. Piezoelectric materials such as quartz, lithium sulfate, barium titanate (among others) are used as the active element (crystal) of ultrasonic transducers.

PIP	A pulse displayed on the cathode ray tube.
PULSE	An electrical signal which rises and falls very sharply.
REFLECTION	A change in wave direction caused by the wave striking an acoustic boundary. The angle of reflection will equal the angle of incidence.
REFRACTION	Refraction is the change in velocity and direction of wave movement when passing through two dissimilar mediums due to the change of impedance.
RESOLUTION	The ability to distinguish clearly between closely proximate reflections.
RINGING	Excessive vibrating of a transducer crystal after electric excitation.
SENSITIVITY	Ultrasonic sensitivity is the ability to detect small reflecters in a test material.
SHEAR MODE	A form of ultrasonic vibration wherein the particle motion within the test material is perpendicular to the direction of propagation.
SHEAR WAVES	Ultrasonic waves whose particle displacement is mainly perpendicular to the direction of movement. Also termed transverse waves.
SNELL's LAW	Used to calculate refracted angles when an ultrasonic beam passes from one medium into another. Longitudinal waves: $\frac{\sin\phi 1}{\sin\phi L} = \frac{V l 1}{V l 2}$ where $\phi 1$ = angle of incidence ϕL = angle of longitudinal refraction $V l 1$ = velocity of longitudinal waves in the 1st medium

SNELL's LAW (Cont'd)

VL2 = velocity of longitudinal waves in 2nd medium

Shear waves:

$$\frac{\sin\phi 1}{\sin\phi s} = \frac{VS1}{VS2}$$

where $\phi 1$ = angle of incidence
ϕs = angle of shear refraction
Vs1 = velocity of shear waves in 1st medium
Vs2 = velocity of shear waves in 2nd medium

SWEEP — A line on a cathode ray tube caused by a spot moving or "sweeping" across the screen.

SYNC or SYNC PULSE — An electronic synchronizing signal used for initiating an action.

TRACE — The picutre on the cathode ray tube.

TRANSDUCER (Crystal or Search Unit) — A device which transforms energy from' one form to another. In this case, from high frequency electrical energy to high frequency mechanical energy and vice versa.

ULTRASOUND — Inaudible sound with a frequency greater than 20,000 cycles per second.

VELOCITY — The speed at which an ultrasonic pulse travels through a given medium.

$$\text{Velocity} = \frac{\text{Distance}}{\text{Time}}$$

WATER PATH	In immersion testing, the distance between the transducer face to the entry surface of the test material.
WAVEFORM	A graph plotting voltage versus time.
WAVELENGTH	The length of one complete wave as measured from any two points in the same phase.

APPENDIX B

PRINCIPLES OF ULTRASONIC INSPECTION

B1.0 Introduction:

The purpose of this section is to present a brief introduction to the basic concepts upon which ultrasonic inspection is based as well as to familiarize the test equipment operator with typical test procedures.

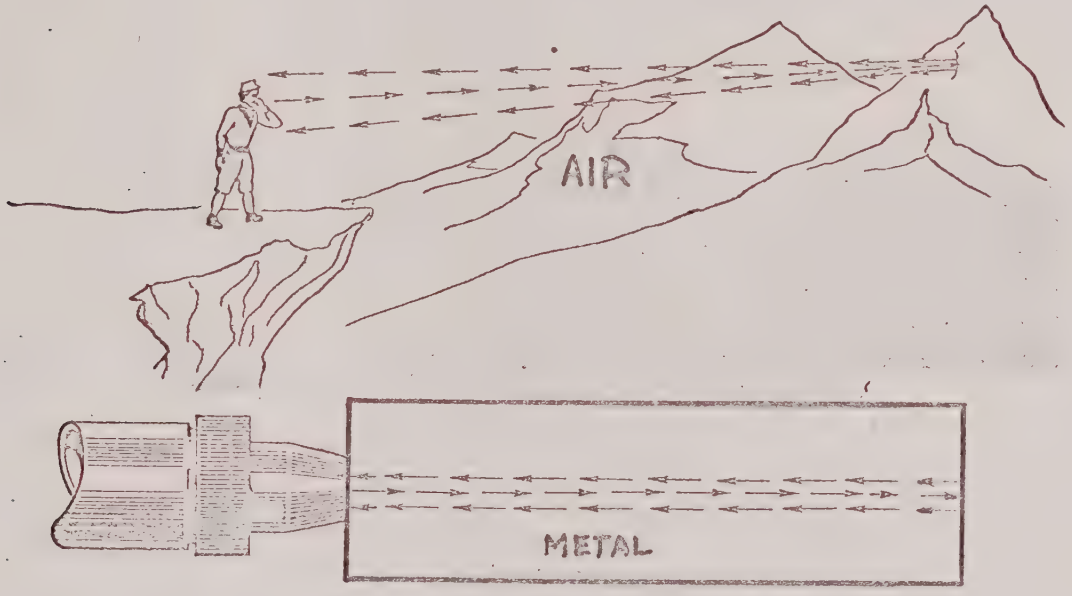


Figure B-1

B1.1 Basic Concepts

B1.1.1 Ultrasonic Waves

The term ultrasonic refers to all vibrational or pressure waves above the frequency of 20,000 cycles per second. Most pressure waves below the frequency of 20,000 c.p.s. are within the normal audible range. The frequencies employed in ultrasonic inspection are far beyond the upper limits of the audible threshold, normally ranging from 0.5 to 25 megacycles (500,000 to 25,000,000 c.p.s.).

Ultrasonic waves have a number of important characteristics which make them useful for inspection purposes:

1. Although they are rapidly attenuated in gases, they will travel relatively long distances through liquids and solids.
2. They tend to travel in straight well-defined beams.

3. The velocity at which a specific type of ultrasonic wave will travel remains constant throgh a given medium.
4. They will change their mode of vibration under certain conditions as at the interfaces of materials having different physical properties; specifically, the density and elasticity of the materials are to some degree reflected from the surfaces of materials and from discontinuities within the material.

These characteristics of ultrasonic waves make them extremely useful in nondestructive flaw inspection. With proper instrumentation for propagating the waves through the test material and analysing their movement, ultrasonic waves will provide the test operator with very specific information regarding the composition of the material under test.

B1.1.2 The Generation of Ultrasonic Waves

Ultrasonic waves are generated by applying an electric pulse to an energy converter called a transducer. This is accomplished by producing a pulse of the desired frequency at a precise time, then converting the pulse into ultrasonic vibrations by means of a piezoelectric crystal. The crystal is actuated for a controlable period of time (usually 1 or 2 microseconds) resulting in a short burst of ultrasonic vibrational waves. This transformation of electrical energy into mechanical energy is the characteristic of piezoelectric materials. When an electric pressure or voltage is applied across a piezoelectric material, its thickness will vary as the frequency of the applied voltage. Conversely, if mechanical pressure is applied to the material, it will generate a small voltage of the same frequency as the applied mechanical vibration. An ultrasonic transducer, then, is essentially a crystal composed of some piezoelectric material which alternately converts electric voltage into mechanical vibrations and then mechanical vibrations into an electric voltage. The resultant output of the transducer is a continuing series of short bursts. Study Figure B-2.

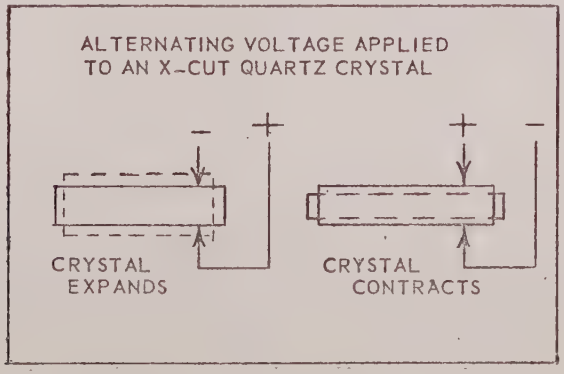


Figure B-2 Generation of Ultrasonic Vibrations

Common piezoelectric materials used for transducer crystals are quartz, lithium sulphate, and some of the polarized ceramics.

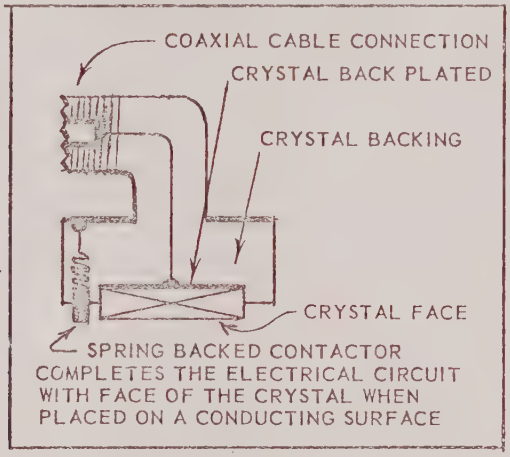

COAXIAL CABLE CONNECTION
CRYSTAL BACK PLATED
CRYSTAL BACKING
CRYSTAL FACE
SPRING BACKED CONTACTOR COMPLETES THE ELECTRICAL CIRCUIT WITH FACE OF THE CRYSTAL WHEN PLACED ON A CONDUCTING SURFACE

Figure B-3 Typical Search Unit

B1.1.3 Couplant

The actual movement of a transducer is infinitesimal; it is often described as acceleration without motion. To transmit such a small amount of energy into a material, it is necessary to use a couplant, typically water, glycerine, oil, or grease. The sole purpose of the couplant is to provide an accoustically good medium for the passage of ultrasonic vibrations from the transducer crystal to the test material.

In immersion testing, both the transducer and the test material are submerged in a couplant; usually, water with a wetting agent and an anti-corrosion agent added.

In contact testing, a thin couplant film, typically, an oil, is used between the transducer face and the material. Sperry couplants 50A4084, 50A4085, and 50A4086 are excellent all around cou-

plants which work well on rough, vertical, or overhead surfaces, and up to temperatures of 1000°F.

B1.1.4 Ultrasonic Reflection

An ultrasonic wave is reflected whenever a change occurs in the medium which is supporting the wave. The behavior of an ultrasonic pulse can be compared to a beam of light travelling through space and being reflected from a number of mirrors. The path travelled and the return of the beam to its source depends upon the angles at which ir impinges upon the reflecting surfaces, as well as the number and location of these surfaces. (Figure B-4)

Ultrasonic reflections occur whenever the elastic properties of the medium change; hence, inclusions, cracks, porosity, and voids as well as the surfaces of a part cause reflections. Since the wave cross section is usually larger than most internal flaws, the amplitude or amount of reflection gives an indication of the relative size of the defect.

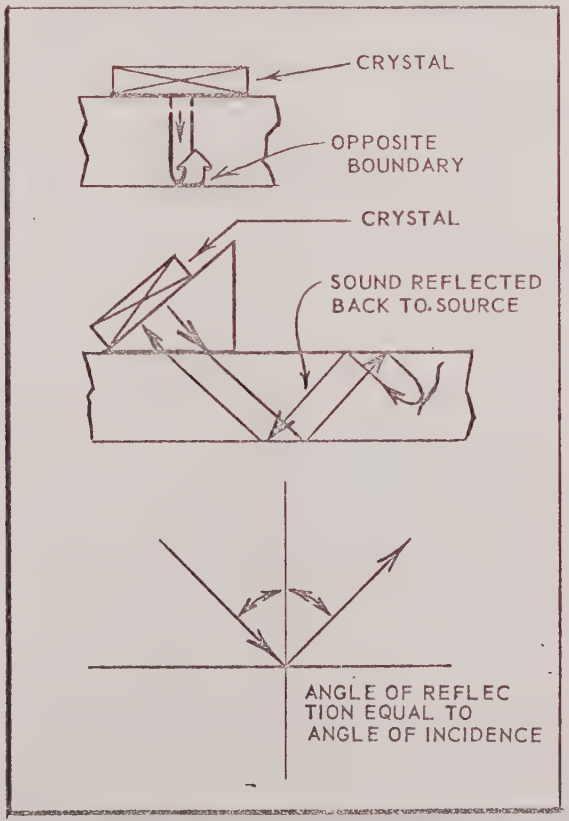


Figure B-4 Reflection of the Ultrasonic Beam

When an ultrasonic wave encounters an interface or second medium, energy is reflected in accordance with the rule, "The angle of reflection is equal to the angle of incidence."

The amount of energy reflected rather than transmitted from one wave supporting medium to another depends on the lack of acoustical similarity between the two media. Since the elastic property of air differs widely from that of any solid, cracks and voids provide 100% reflection.

B1.1.5 Ultrasonic Refraction

Ultrasonic waves are refracted when they pass from one medium to another at an angle other than normal, that is, other than perpendicular.

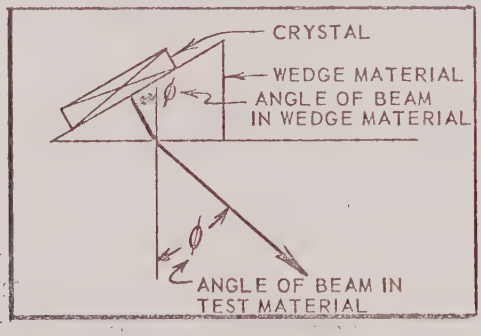


Figure B-5 Refraction of the Ultrasonic Beam

Simply stated, refraction is a change in the angle of wave propigation coused by a change in the acoustic properties of two dissimilar mediums. Refraction of the ultrasonic beam when passing at an angle from one material to another is comparable to the refraction of a light beam when passing through two dissimilar mediums (for example: The apparent displacement of an object in water from its actual position, when viewed at any angle other than normal to the water surface).

B1.1.6 Modes of Ultrasonic Propagation

There are several modes of ultrasonic wave propagation. The two most commonly used in flaw detection are longitudinal waves and shear waves. In more limited use are surface waves and lamb waves.

a. Longitudinal waves: When ultrasonic waves pass into a material at an angle perpendicular to the material surface, the wave

propagation will be longitudinal. The particle movement within the material will be along the same direction as the wave direction. The waves are compression waves as are audible sound waves.

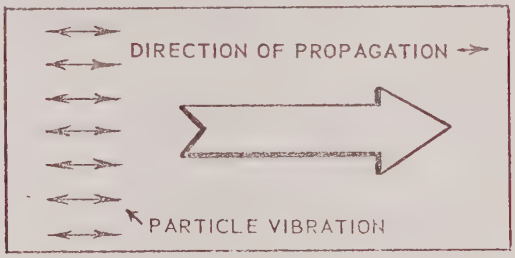


Figure B-6 Longitudinal Waves

b. Shear waves: When ultrasonic waves enter a material at an angle other than perpendicular, particle displacement motion becomes increasingly transverse to the direction of wave movement. As the angle of incidence increases, there is an increase in "mode conversion" from longitudinal to shear waves. An angle called the 1st critical angle will be reached when longitudinal waves are no longer propigated and only shear waves will be passing through the material. The main factor to be remembered in working with shear waves is that the velocity of a shear wave is approximately one half that of a longitudinal wave.

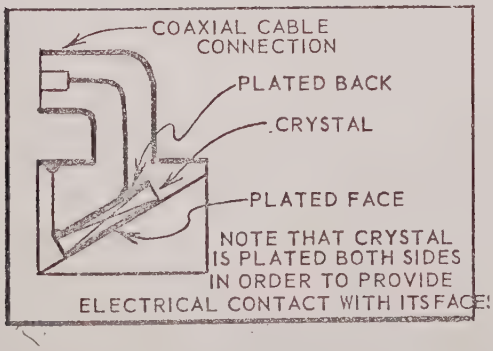

COAXIAL CABLE CONNECTION
PLATED BACK
CRYSTAL
PLATED FACE
NOTE THAT CRYSTAL IS PLATED BOTH SIDES IN ORDER TO PROVIDE ELECTRICAL CONTACT WITH ITS FACE

Figure B-7 Angle Beam Search Unit

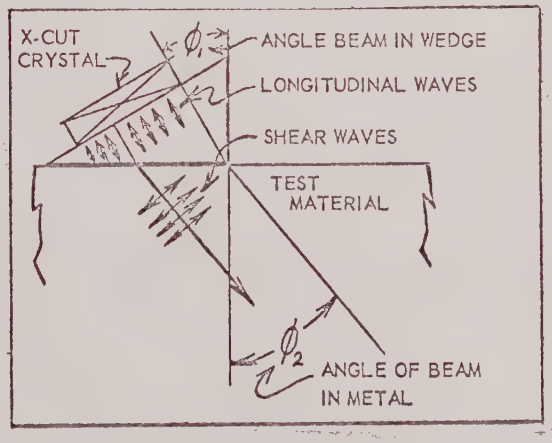


Figure B-8 Generating Shear Waves in Metals

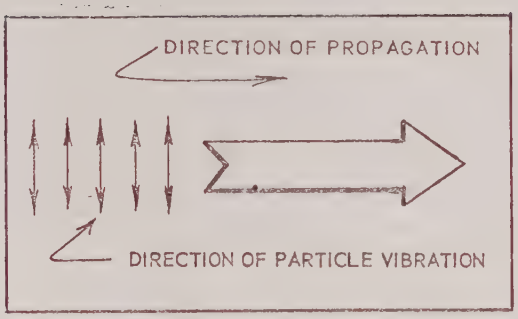


Figure B-9 Shear Waves

c. Surface waves: If the incident angle is increased further, the second critical angle will be reached when all waves propigated are "surface waves." The term is descriptive: the waves are confined to a narrow region on and just below the surface. The particle displacement of the wave motion follows an elliptical orbit in which the major axis of the ellipse is perpendicular to the surface and the minor axis is parallel to the direction of propagation.

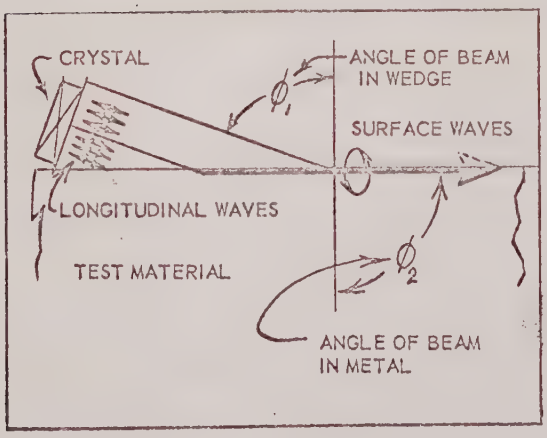


Figure B-10 Generating Surface Waves

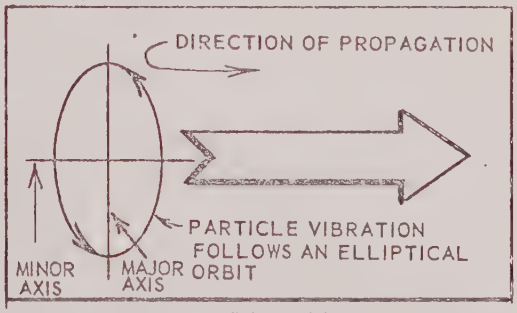


Figure B-11 Surface Waves

Surface waves will travel along smooth rounded contours, but are reflected at abrupt edges. (Figure B-11)

d. Lamb waves: In thin sheet material or thin walled tubing, a type of wave called the "lamb wave" can be propagated. This is possible only when the thickness of the material is approximately comparable to the wavelength of the waves propigated. Lamb waves can exist in two types and many possible modes. The particle motion of the two types, symmetrical and asymmetrical, are illustrated in Figure B-12.

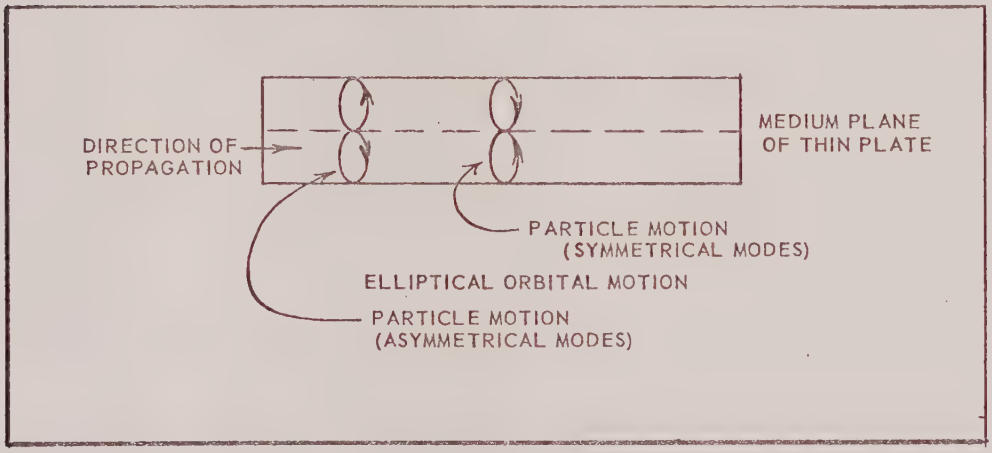


Figure B-12 Particle Motion

B1.1.7 Ultrasonic Flaw Detection

Ultrasonic flaw detection is accomplished by positioning a transducer in such a position that the desired wave mode will be generated in the test material. The energy passes from the transducer, through the couplant, is partially reflected from the entry surface, passes through the material and is reflected from the rear surface (if the surfaces are parallel). If a discontinuity exists between the surfaces, an echo will be reflected from it as well. Since the velocity of the wave motion remains constant throughout the material, the time difference between entering the material and its reflection from the far surface can be used to establish the distance traveled. With the material boundaries established, the depth of discontinuity can be readily established by measuring the time (distance) from its echo to either the front or back reflections. The amount of energy returned by reflection from the discontinuity will give an indication both of its size and orientation .

B1.1.7.1 Instrumentation (Figure B-13)

The basic instrumentation necessary to transmit and receive ultra-

sonic pulses consists of a pulse generator, a transducer, a receiver, and a pulse display unit.

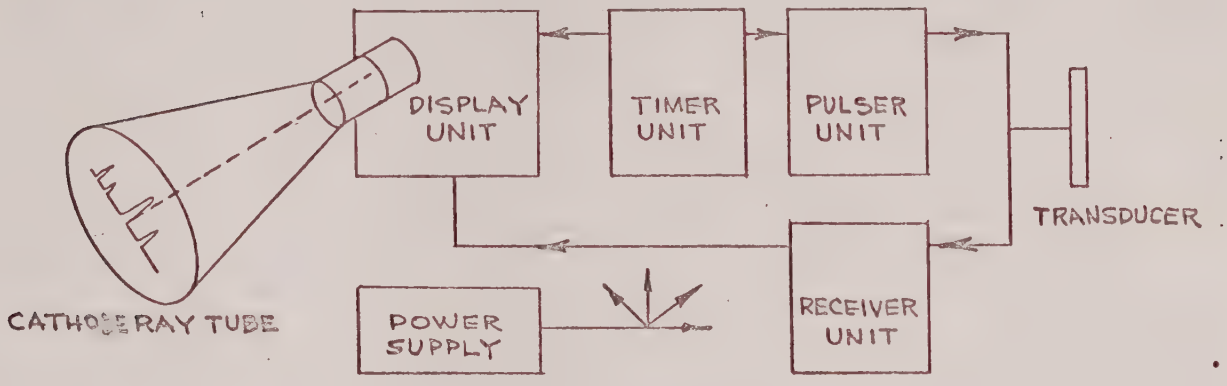


Figure B-13 Diagram of Typical Ultrasonic Flaw Detector

Naturally, the degree of inspection accuracy, clarity of display, test sensitivity and other features will greatly influence the design of any ultrasonic instrument and, in general, add to its complexity. The basic operation of such a system, however, remains unchanged and functions essentially as follows:

The pulse generator sends out electrical pulses of very short duration (usually one microsecond or less) at a rate which ranges from 100-2,000 pulses per second. Several different rates within this range can be selected by the operator. Since each pulse is of short duration, it is clear that there exists a long period of time after each pulse when no transmission occurs. During this time, the receiver is afforded an opportunity to "listen" for returning echoes or reflections from within the material under test.

The transducer, which has already emitted an ultrasonic pulse as a result of the applied electrical pulse, receives portions of this pulse as it is reflected back from discontinuities in the material. Operating in reverse, the transducer now generates electrical pulses which are then coupled to the receiver which amplifies them.

Through the use of timing circuits, all of the signals handled by the receiver, including the initial transmitted pulse, are arranged in the order of their occurrence and presented as vertical pulses or "pips" along a time base line of a cathode ray

tube. This time base line is caused by a spot moving rapidly across the picture tube and is controlled by the synchronizer to provide a time base for the analysis of the information. The motion of this spot is called the SWEEP. The earliest time is represented by the left end of the sweep and the time increases toward the right. A delay control is provided to move the sweep back and forth so that segments of time which are off the screen, either to the right or left, can be brought into view and the operator can select the segment of time which contains the echo pips which he wishes to see. The transducer may receive a large number of unwanted echoes caused by reverberations within the test sample which can be eliminated by selecting and expanding to full screen size only that time segment which contains the significant echoes.

a. Resolution

Resolution is generally interpreted as the ability of an ultrasonic test facility to clearly distinguish between closely proximate signals. Resolving power is often of particular importance in the "near field", the area of material just beneath the entry surface. Resolving power will vary from one material to another, from one type of surface to another and from one material geometry to another. Resolving power will also vary with operating frequency, type of transducer, type of instrument and proficiency of the operator. Under ideal conditions, the resolution which can be achieved using the most popular application technique associated with ultrasonic testing is 1/8 inch in aluminum. When conditions are not ideal, $\frac{1}{4}$ inch or even $\frac{1}{2}$ inch is not uncommon. Fortunately, special techniques have been worked out which for many cases effectively cancel the resolution restriction normally related to a particular test.

b. Sensitivity

Ultrasonics is capable of penetrating metals to a depth of one hundred feet or more, although such power is seldom available in commercial equipment. The reason for this is rather elementary and serves to illustrate an important consideration regarding sensitivity. Very high instrument sensitivity can only be achieved by sacrificing instrument resolving power. Since most testing problems involve samples less than several feet thick, specific attention is given to optimizing maximum useful sensitivity with highest resolving power.

In testing metals, metallurgical differences such as grain size, alloying constituents, heat treatment and mechanical working contribute greatly to the total number of reflections which will be observed in a material. When the level of sensitivity is very high, many reflections can be received which do not in themselves indicate the

existence of a rejectable condition. Most often, the user will find that the proper operating sensitivity necessary to perform a particular test is much lower than the equipment's total capability. The actual level used is frequently determined through the use of reference standards such as the ASTM test blocks discussed in the following paragraphs.

c. Reference Standards

In ultrasonic testing, testing a standard reference us usually desirable to establish a specified test sensitivity. Ideally, standards should be constructed from the same material as that being tested and calibrated to allow for variations in metal distance and flaw size. Since the airframe industry was among the first to use ultrasonic testing, it is not surprising that an ASTM specification has been developed to cover the fabricating and checking of aluminum alloy ultrasonic standard reference blocks (ASTM Designation E 127-61T). In general, the techniques used in this specification are applicable to other metals as well; hence, a copy of this specification should be obtained if the user intends to fabricate his own standards. Copies can be procured by writing directly to the American Society for Testing Material, 1916 Race Street, Philadelphia 3, Pennsylvania ($.50 ea.).

Test blocks are usually constructed by drilling a hole approximately 3/4 inch deep opposite the entry surface. The diameter of the hole is 1/64 inch or multiples of 1/64 inch (i.e., 3/64, 5/64, etc.). The hole size is commonly called by the multiplier for example, a 3/64 inch diameter hole would be referred to as a number three (#3) hole. After the hole is inserted in the block, the hole bottom is made first through the use of a flat faced drill. The hole entrance is then sealed with a suitable plug to limit surface corrosion.

The distance the flat bottom hole will be from the entry surface will be dictated by the size of the part to be tested. Usually, it is desirable to have blocks of various distances to insure that complete inspection of the part is being accomplished. The accepted designation for this distance between the flaw and the entry surface is taken as the block size, hence, the physical size of a test block is always greater by three quarters of an inch than the stated block size. Tables B-1 & B-2 illustrate the blocks recommended in the basic ASTM sets.

TABLES B-1 AND B-2

Dimensions and Identification of Refere .ce Blocks in the Basic ASTM Set.

TABLE B-1

Hole Diameter	Metal Distance	Overall Length	Block Ident.
3/64	3.000	3.750	3 - 0300
5/64	0.125	0.875	5 - 0012
5/64	0.250	1.000	5 - 0025
5/64	0.500	1.250	5 - 0050
5/64	0.750	1.500	5 - 0075
5/64	1.500	2.250	5 - 0150
5/64	3.000	3.750	5 - 0300
5/64	6.000	6.750	5 - 0600
8/64	3.000	3.750	8 - 0300
8/64	6.000	6.750	8 - 0600

TABLE B-2

Hole Diameter	Metal Distance	Overall Length	Block Ident.
1/64	3.000	3.750	1 - 0300
2/64	3.000	3.750	2 - 0300
3/64	3.000	3.750	3 - 0300
4/64	3.000	3.750	4 - 0300
5/64	3.000	3.750	5 - 0300
6/64	3.000	3.750	6 - 0300
7/64	3.000	3.750	7 - 0300
8/64	3.000	3.750	8 - 0300

d. Choice of Test Frequency

From the discussion of resolution and sensitivity (see pages it will be seen that two basic principles should be considered when choosing the frequency at which a particular test should be conducted.

1. The highest frequency will provide the greatest sensitivity for detection of small defects as well as detection of all forms of metallurgical discontinuities.

2. The lowest frequency will provide the greatest depth of penetration.

In general, higher frequencies provide more detailed information permitting echoes to be received from closer to the surface, smaller reflecting surfaces, ans boundaries between media which are not greatly different in ultrasonic properties. Lower frequencies provide greater penetrating power through highly attenuative media such as bond structure. Usually, a frequency is selected which gives the best compromise between the above, the highest frequency which gives adequate penetration being selected.

Table B-3 gives a very general guide to common frequencies employed for various inspection applications.

TABLE B-3

APPLICATION FREQUENCIES

Frequency Range	Test Application
1 MHz	Castings: Course Grained Materials, Gray Iron, Nodular Iron, Copper and Stainless Steel.
1 MHz to 2.25 MHz	Castings: Fine Grained Materials, Steel, Aluminum, Brass, Etc. Plastics, Propellants, and Powder Grains Welds (Ferrous and Nonferrous)
2.25 to 5 MHz	Drawn and Extruded Products: Bars, Tubes and Shapes (Ferrous and Non-Ferrous) Forgings (Ferrous and Non-Ferrous) Glass and Ceramics Rolled Products: Metallic Sheet, Plate, Bars and Billets
5 MHz and Above	Small Forgirgsand Worked Materials with Refined Grain Size

e. Surface Condition Requirements

Efficient inspection requires a suitable test surface on the material being inspected. The following general rules should be used as a guide for surface conditioning prior to testing.

1. Machined surfaces under 125 microinch roughness are usually satisfactory for most testing. For detection of defects 1/64 or smaller, a finish under 63 microinches is normally required.

2. Rolled or forged surfaces are usually satisfactory if loose dirt and scale are removed. In some cases, special cleaning and smoothing with a sander or power brush may prove necessary. Scale itself, if reasonable smooth and securely bonded to the metal, need not be removed for testing.

3. Irregular surfaces obviously are the most difficult to test. Usually, a disc sander can be used to smooth our a flat test surface large enough to accomodate the transducer. In such cases, it may be necessary to make spot checks rather than conduct 100% inspection.

B2.0 Basic Testing Methods

B2.1 Testing Standards and Specifications

SOCIETY FOR NONDESTRUCTIVE TESTING, INC.
914 Chicago Avenue, Evanston, Illinois

SNT Airframe Committee

Recommended Ultrasonic Acceptance Standards for Airframe Aluminum Alloy Plate, Forgings and Extrusions.

Reference Texts

Nondestructive Testing Handbook in Two Volumes

AMERICAN SOCIETY FOR TESTING AND MATERIALS.
1916 Race Street, Philadelphia, Pennsylvania

ASTM No.	TITLE
A435-59T	Ultrasonic Testing and Inspection of Steel Plates of Firebox and Higher Quality
A418-57T	Ultrasonic Testing and Inspection of Turbine and Generator Steel Rotor Forgings
E164-60T	Ultrasonic Contact Inspection of Weldments
E114-55T	Recommended Practice for Ultrasonic Testing by the Reflection Method, Using Pulsed Longitudinal Waves Induced by Direct Contact.

A388-59 Ultrasonic Testing and Inspection of Heavy Steel Forgings.

B2.2 Conventional Inspection

Most ultrasonic testing can be performed by using a single straight-beam transducer. This method of testing is usually considered to be the conventional approach. By using this method, a flaw can be detected in one of two ways. A pip can appear on the trace of the cathode ray tube which will indicate the presence of a flaw directly, or the back surface pip appearing on the trace of the CRT may drop in amplitude, indirectly indicating the presence of a flaw. The latter technique has proven to be of considerable value when the orientation of internal flaws are of a random nature. It should be kept in mind that flaws which do not occur at right angles to the oncoming beam will deflect the wave in such a manner that little or no reflection is obtained from the flaw itself.

Figure B-14 illustrates what occurs as an ultrasonic wave passes through a sample. In actual practice, some of the energy reflected from a flaw or back surface will be reflected back into the part a second time when it strikes the entry surface. As a matter of fact, theis process of reflecting back and forth will be repeated many times until all of the wave energy is absorbed by the material and dissipated as heat. The presence of reflection multiples can be confusing to a new operator; however, once the relevant signals are identified, the equipment can be adjusted to obscure these unwanted multiples.

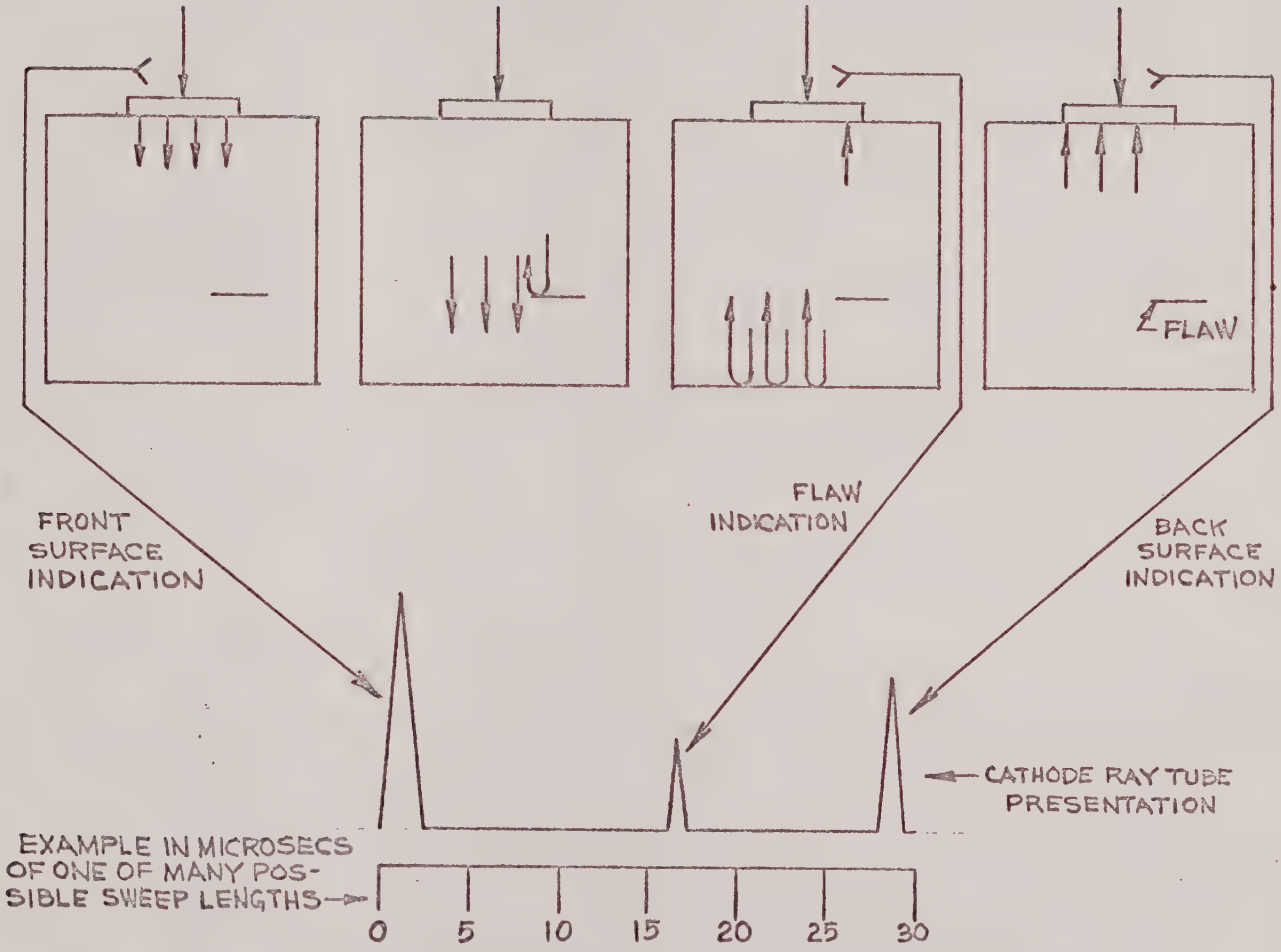


Figure B-14 Conventional Inspection Method

Normally, the operator will have little difficulty in identifying flaws with respect to size and location. Occasionally, multiple reflections from a defect close to the entry surface will occur before the first reflection from the back surface is received. As illustrated in Figure B15 each succeeding reflection is lower in amplitude and equally spaced along the time base. Retesting the material from the reverse side is recommended in order to determine if a single flaw with multiples is present or if the material contains several flaws.

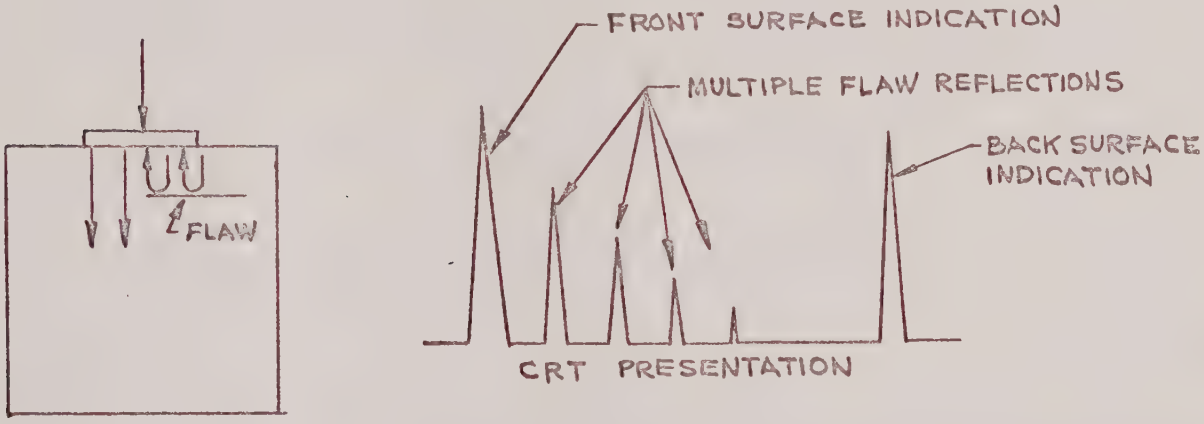


Figure B-15 Multiple Back Reflections

B2.2.1 Multiple Reflection Inspection

A variation of the conventional method of inspection is the multiple reflection technique. Figure B16 illustrates the CRT presentation used. As ultrasonic energy propagates between the front and back surfaces of a material, the height of each succeeding pulse is dependent on the preceding one; hence, the number of multiples, or more correctly, the lack of a certain number of multiples, is an indication of ultrasonic attenuation. Changes in attenuation may be caused by flaws, internal stresses, incorrect heat treatment, differences in the physical or chemical structure of a material, etc. This method has been found very effective when sufficient information concerning the material to be tested is available.

(a) (b)

Figure B-16 Various Back Reflections

(a) Typical back reflections from sound material,
(b) Back reflections from porous material - gain setting same as shown in (a).

B2.2.2 Angle-Beam Inspection

Angle beam inspection is similar to straight beam or compression wave inspection except the transducer is designed to transmit ultrasonic pulses into the work piece at an angle. To avoid creation of several dominant waves in the material at the same time, angle-beam transducers are designed to produce only shear waves. From an application standpoint, shear waves may be treated the same as longitudinal waves so long as it is remembered that the speed or velocity of the wave is only approximately one half that of the more conventional longitudinal wave. Figure B17 illustrates how this wave is transmitted.

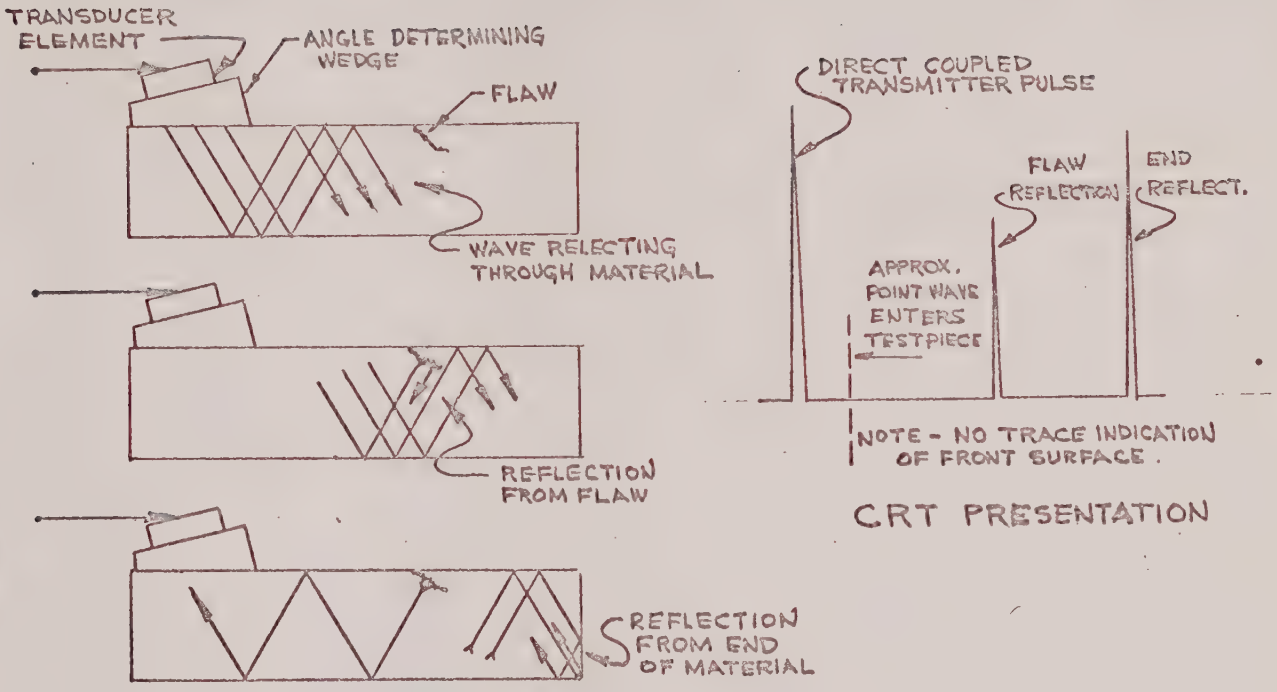


Figure B-17 Angle Beam Inspection Method

B2.2.3 Through Transmission Inspection

In addition to the inspection methods involving one transducer for sending and receiving, a two-transducer system is sometimes used. The most important advantage to this technique is that it provides great resolving power. As illustrated in Figure B18, energy is transmitted directly through the part and received by a second transducer on the opposite side. Although no direct flaw indication is observed using this technique, loss of amplitude of the received signal indicates the presence of a flaw. Through-transmission inspection is often used in the inspection of highly attenuative materials.

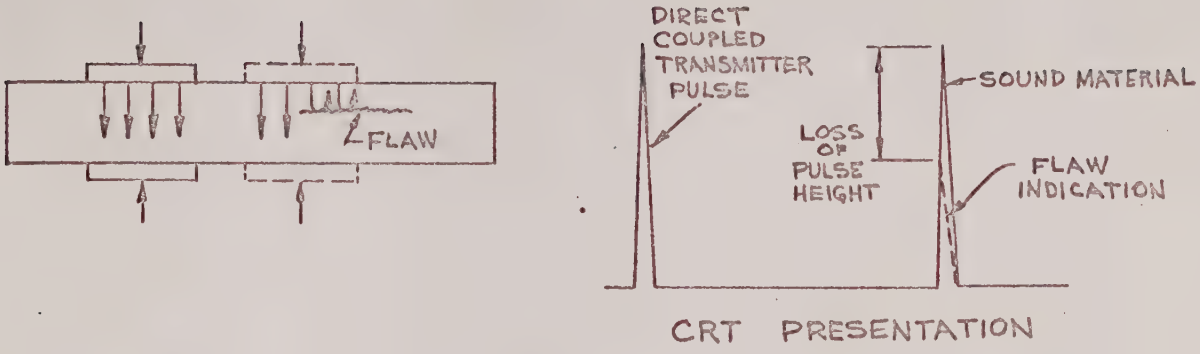


Figure B-18 Through Transmission Method of Inspection

B2.2.4 Immersion Testing

Ultrasonic testing is many times best accomplished through the use of immersion techniques. In the following section, a variety of immersion testing situations are presented.

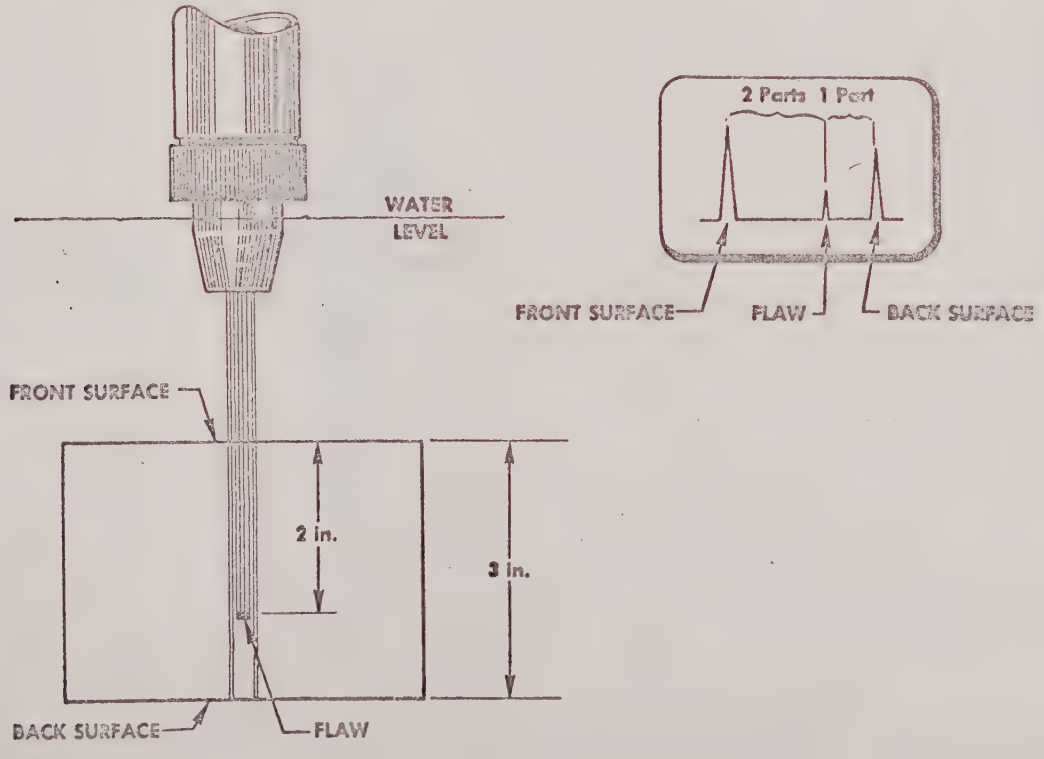


Figure B-19 Type 1, Display Interpretation

B2.2.4.1 Type 1: (See Figure B19) The sample, in this case, would be a smooth surfaced rectangular or cylindrical block with parallel surfaces which can be placed directly under the search tube and at right angles to it. In such a case, clear pips representing the front and back surfaces of the material will be seen, and any flaw pips which are present will appear between these two. The DELAY control and the IN/DIV switch can be adjusted so that the pips representing the front and back surfaces are spaced as widely as possible on the scope to give maximum accuracy in reading the depth at which any flaws are located. The horizontal scale markers assist in determining the location of flaws. The echo from the front surface of the metal returns first and is located at the left-hand side of the screen. The echo from the back surface of the sample arrives last and is located at the extreme right of the screen. A pip which is located two-thirds of the distance from the front echo indicates a flaw which is two-thirds of the thickness of the sample below the upper surface. If the flaw is sufficiently large, all of the remaining sound may be reflected from it. In this case, the back surface echo will disappear because the flaw is casting an ultrasonic shadow on the back surface.

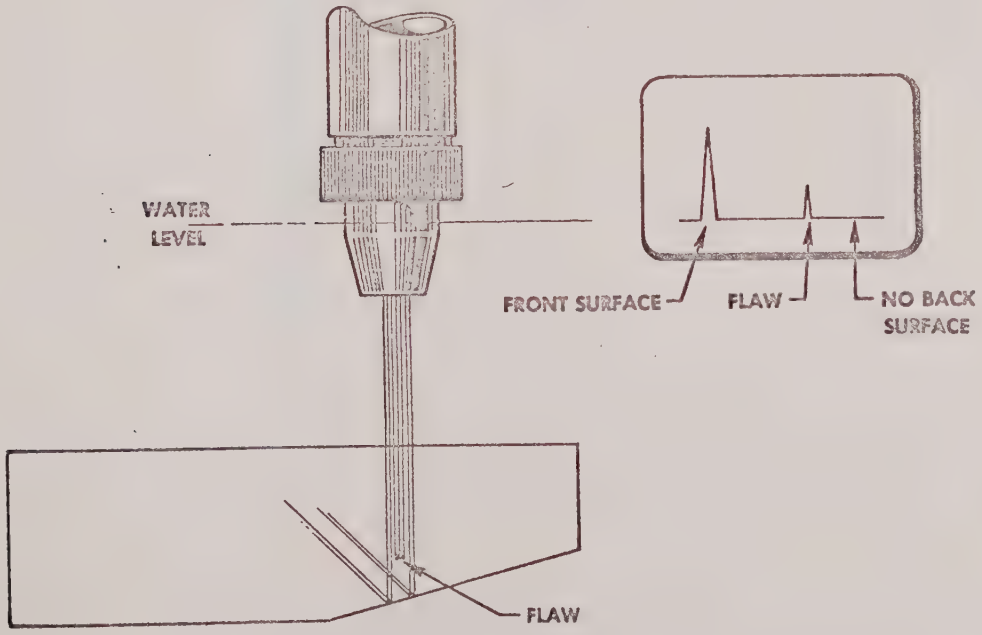


Figure B-20 Type 2, Display Interpretation

B2.2.4.2 Type 2: (See Figure B20) Type 2 situations a those in which the back surface of the sample to be tested is not parallel to the front surface. When the sound waves reach the back surface, they will be reflected at an angle and will not return to the transducer. The pattern on the screen will not have a right hand pip which represents an echo from the back surface. I a second pip does appear, it probably represents a flaw. If there is any question as to whether this second pip is a flaw or an echo from the back surface, check the setting of the IN/DIV switch. If a pip appears on the horizontal scale of the CRT at a point which represents less than the total thickness of the test piece, the pip is a flaw indication.

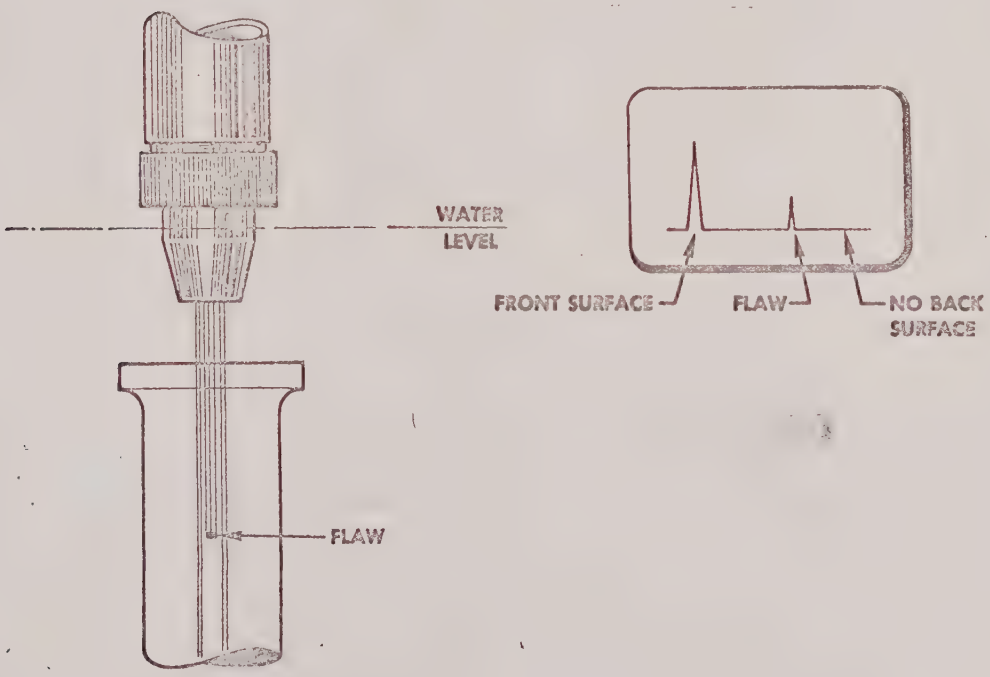


Figure B-21 Type 3, Display Interpretation

B2.2.4.3 Type 3: (See Figure B21) The sketch shown for Type 3 indicates a situation in which the depth of the material through which the sound waves have to pass is so great that the energy is attenuated before it can return. Any pip to the right of the one representing the front surface will be from a flaw or geometric boundary. The IN/DIV switch and horizontal scale of the CRT will

indicate the distance below the testing surface of any received signal.

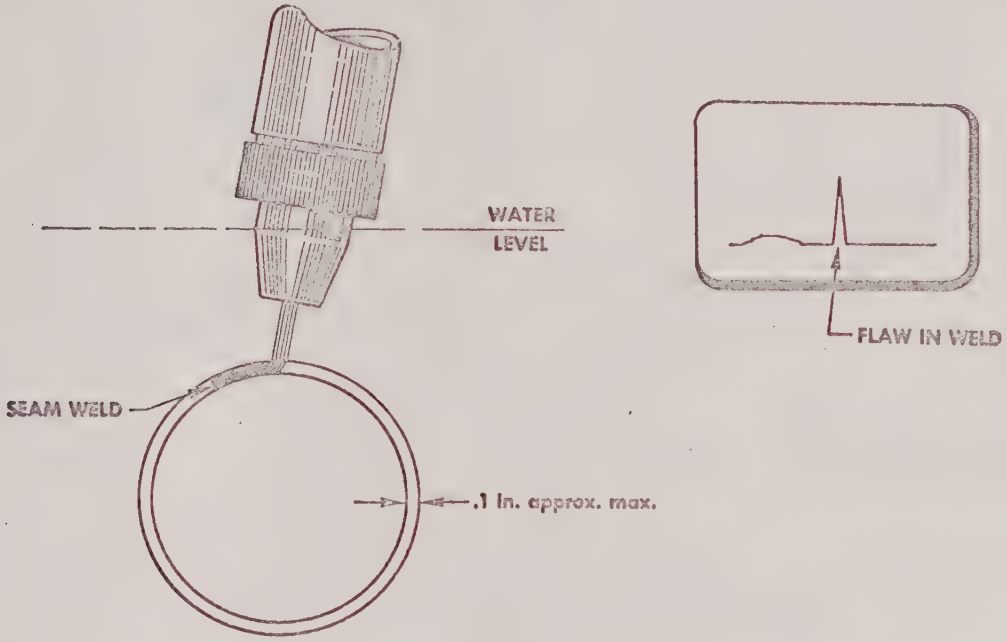


Figure B-22 Type 4, Display Interpretation

B2.2.4.4 Type 4: (See Figure B22) In Type 4, the subject being tested is a seam weld on a piece of thin walled tubing. The behavior characteristics of ultrasound at an acute angle of approach are such that some of the sound energy will be reflected from the surface and be lost. The rest of the energy will become trapped in the circular path of the metal and very little echo will be received from either the front surface or the back surface. Those waves which are proceeding through the wall of the tubing will strike any obstruction in the wall at approximately right angles, and will return an echo from such an obstruction. These conditions will prevail in a tube with walls up to 1/10 of an inch in thickness.

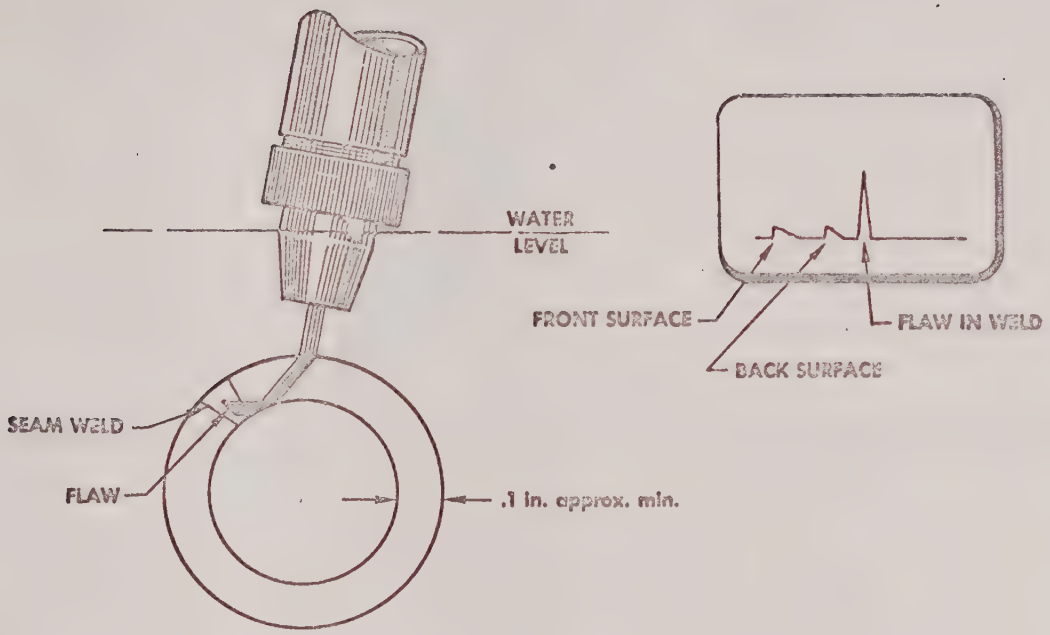


Figure B-23 Type 5, Display Interpretation

B2.2.4.5 Type 5: (See Figure B23) When inspecting a welded tube with a wall thickness in excess of 0.125 inches, you will find refraction conditions are such that pipes may be obtained representing both the outer and inner surfaces of the pipe together with pips from any flaws which may be in the pipe. The differences between the results received under Type 4 and Type 5 are due entirely to the increased thickness of the material of the tube walls in Type 5.

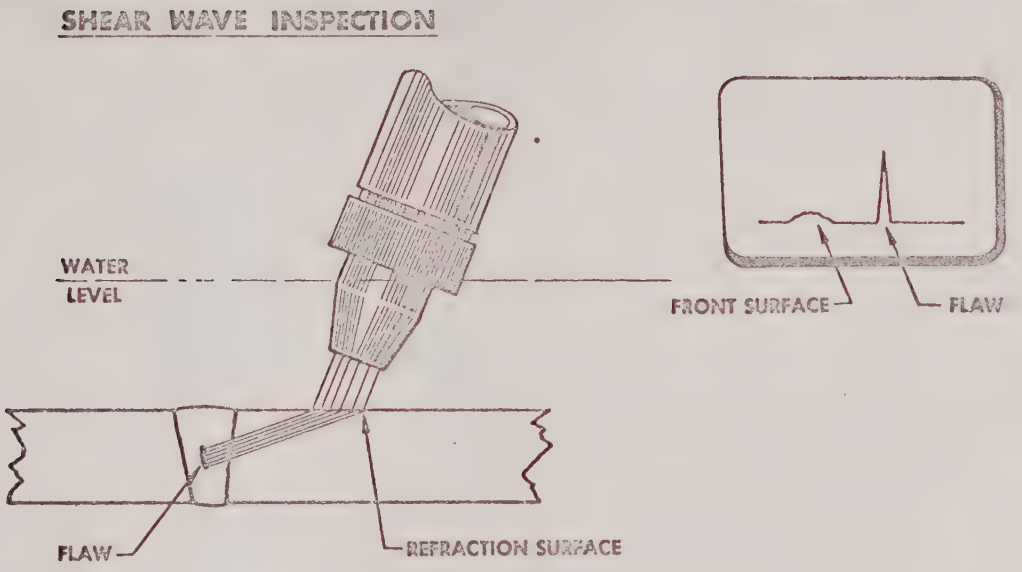


Figure B-24 Type 6, Display Interpretation

B2.2.4.6 Type 6: (See Figure B24) The illustration presented for Type 6 represents the inspection of a weld in a heavy plate. It is necessary to cause the beam to enter from some angle such as 70° from the surface. The ultrasound when it leaves the water and enters the metal will refract such that the beam will be travelling nearly parallel to the metal surface inside the metal.

When the ultrasonic beam enters the metal at some angle other than normal (90°) to the surface, the internal angle will change rapidly for small changes in the external angle. This is due to the fact that the velocity of ultrasound in water is approximately one-fourth of that in steel. For small deviations from normal, such as less than 10°, the angle of refraction will be approximately four times the angle of incidence. If the angle of incidence exceeds approximately 15°, the sound waves will be converted from longitudinal to shear waves which travel at approximately half the velocity of the longitudinal waves. To produce shear waves, tilt the search tube to some angle away from normal that lies between 0° and 33°.

In shear wave inspection, a rather small and poorly defined echo is obtained from the front surface of the material. A strong echo

will be returned from vertical fissures or cracks in the material being inspected. If the search tube is moved horizontally toward or away from the flaw without changing angle, the flaw pip will move toward or away from the front surface pip. This is due to the fact that the acoustic path between the front surface and the flaw is made shorter or longer by the motion of the search tube.

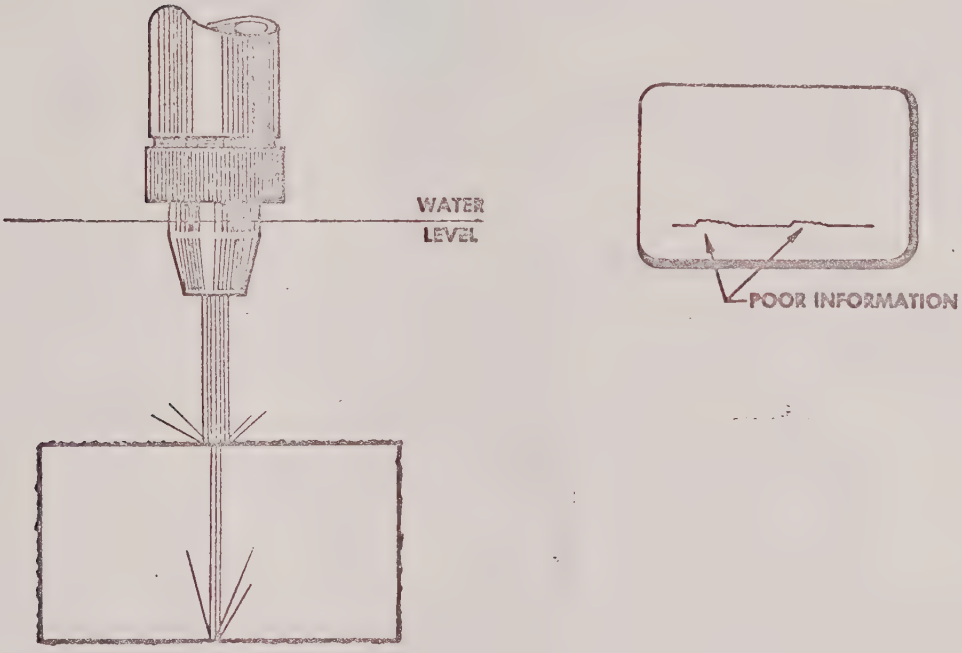


Figure B-25 Type 7, Display Interpretation

B2.2.4.7 Type 7: (See Figure B25) Type 7 represents a situation in which the front surface of the metal is so rough that a complete scattering of the sound waves is obtained. In such a situation, there will be no appreciable penetration into the metal and any possible echoes will also be dissipated by the roughness so that no echoes at all will be received. The solution to such a problem is either to have the surface smoothed sufficiently to allow normal reflection and penetration, or to penetrate the test material through a smoother surface from some other angle. It is also suggested that the lowest frequency transducer available be tried.

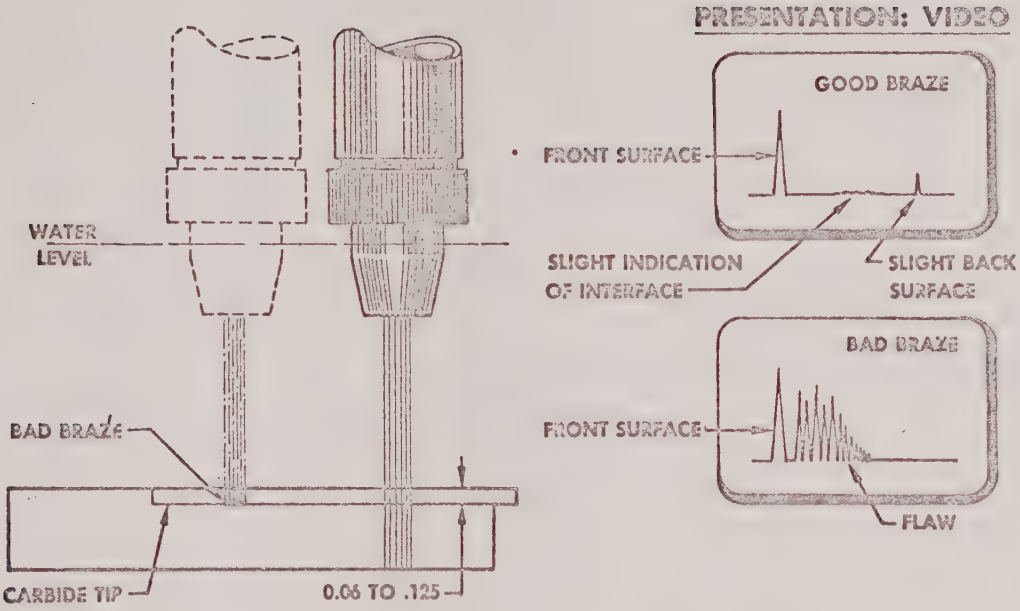


Figure B-26 Type 8, Display Interpretation

B2.2.4.8 Type 8: (See Figure B26) Type 8 represents a situation in which two different materials have been brazed or bonded face to face. Where a good uniform bonding has been obtained, normal front and back pips and a series of very small ridges which represent the two surfaces, the sound waves will be unable to penetrate the void and the pip from the bottom plate will be lost entirely. At the point on the sweep which represents the location of the bonding surfaces, a series of pips like tall grass will appear which represent reverberations of the sound waves within the top plate.

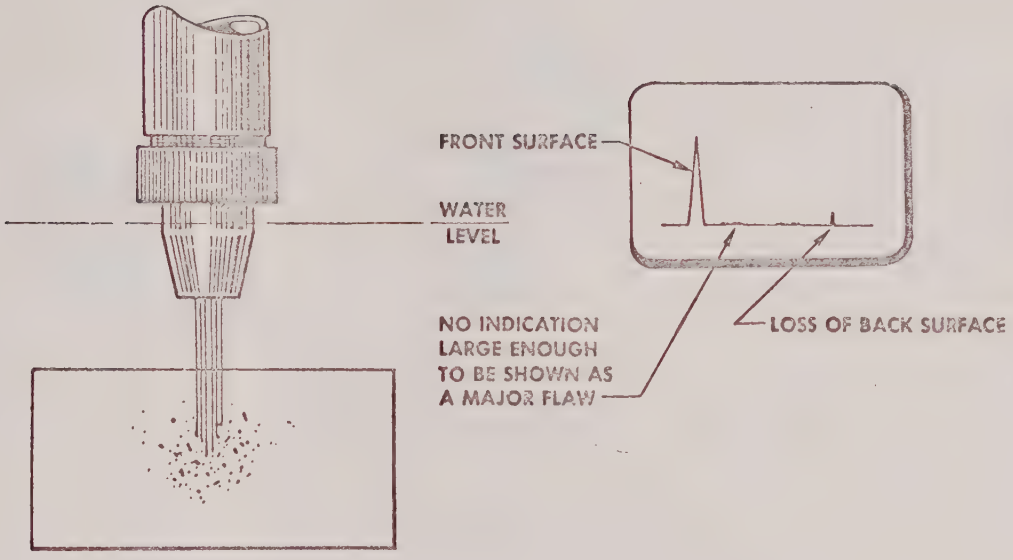


Figure B-27 Type 9, Display Interpretation

B2.2.4.9 Type 9: (See Figure B27) Type 9 represents a situation in which inspection is attempted on relatively porous material. The front pip will be clear, but the back pip will be small or even non-existent, because the ultrasonic waves have either been absorbed or dissipated by the porous nature of the material. The clear pip of the front surface will probably be followed by a long series of bumps or very short "grass", which represent tiny echoes received from the porous structure itself and do not actually represent flaws. If a significant flaw is located within the material, it should create a pip of sufficient size to be recognized. Ultrasound will not penetrate deeply into exceptionally porous materials, especially at the higher frequencies.

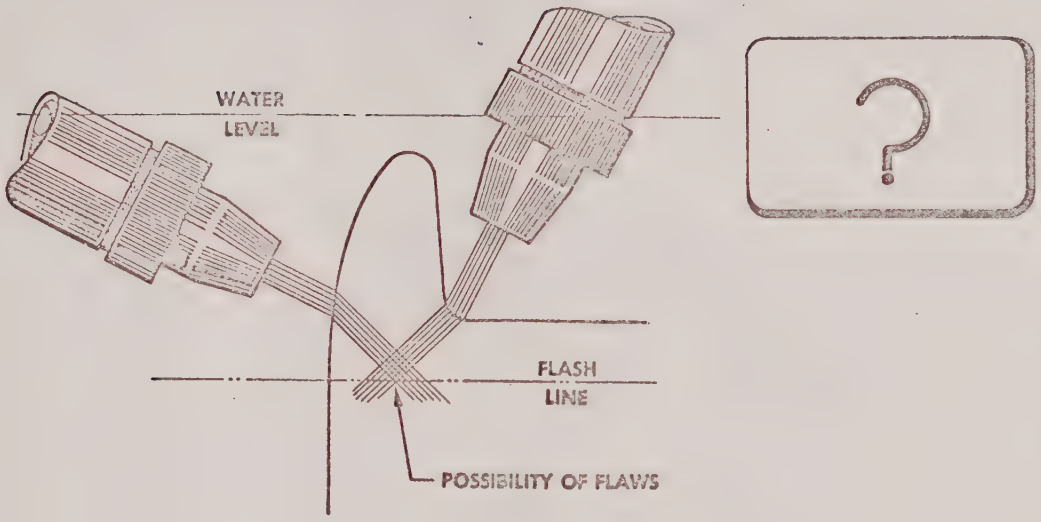


Figure B-28 Type 10, Display Interpretation

B2.2.4.10 Type 10: (See Figure B28) It may be necessary to inspect a sample which involves complex curved surfaces which do not fit any of the types illustrated above. In such cases, it is recommended that Automation Industries, Inc., Sperry Division, be consulted concerning special techniques.

APPENDIX C

PARTS LIST

C1.0 INTRODUCTION

C1.1 This section contains information for ordering and replacing parts for the UM-771/775 Reflectoscope CRT Display.

C1.2 Table C-1 is a list of Reference Designators and Abbreviations which is used in the Text and Parts List.

TABLE C-1

UM-771/775 REFLECTOSCOPE
TEXT ABBREVIATIONS

A.C. = Alternating Current
AMPL = Amplifier

C = Capacitance
CCW = Counter Clockwise
CRT = Cathode Ray Tube
CW = Clockwise

D.C. = Direct Current

F = Farad

GND = Ground

Hz = Cycles per second

K = Kilo = 10^{-3}
KHz = 1000 cycles per second

M = Milli = 10^{-3}
Meg = 10^{-6}
MHz = 1 million cycles per second

N = Nano = 10^{-9}

PF = Picofarads = 10^{-12}

R = Resistor
RF = Radio Frequency

SPDT = Single Pole Double Throw
STL = Steel

U = Micro = 10^{-6}

Continued

UM-771/775 REFLECTOSCOPE REFERENCE DESIGNATORS

ASS'Y = Assembly	L = Inductor
ASTIG = Astigmatism	
ATTEN = Attenuator	P = Plug
AUTO = Automatic	P.C. = Printed Circuit
AUX = Auxiliary	PPS = Pulse per Second
	P/R = Pulser Receiver
CT = Center Tap	PRF = Pulse Repetition Rate
DAC = Distance Amplitude Correction	Q = Transistor
D.S. = Delay Sync	R = Resistor
DEFL = Deflection	
DIFF = Differentiated	S = Switch
	SENS = Sensitivity
F = Fuse	SYC = Synchronization
FET = Field Effect Transistor	
FILT = Filter	T = Transformer
FREQ = Frequency	T/R = Transmit Receive
	TRF = Transmit Receive Frequency
GA = Gated Attenuator	
	µs/IN = Microseconds per inch
HORIZ = Horizontal	
	V = Vacuum Tube
IN/DIV = Inches per Division	VAC = Volts Alternating Current
IF SYNC = Interface Synchronization	VER = Vertical
INT = Intensity	V.S. = Video Sync
	W = Cable
J = Jack	
	X = Socket
K = Relay	
KV = Kilovolts	Y = Crystal

C1.3 The majority of all electrical components capacitors, resistors, etc. are clearly printed on the four P.C. Board Assemblies. For parts identification, parts break-down list will be included. Components other than four P.C. Board Assemblies will be identified by parts drawings and by parts breakdown lists.

C2.0 ORDERING INFORMATION

C2.1 In ordering a replaced part from Sperry Division address the parts order list or inquiry to the Automation Industries, Inc., Sperry Division, Danbury, Conn., U.S.A. and supply the following information:

a. Sperry Instrument model number.
b. Serial number.
c. Desired quantity of parts.
d. Schematic symbol, part number and description.

C3.0 TABLE OF BOARD NUMBERS (TABLE C-2)

C3.1 The below list of four P.C. Board Assemblies are tabulated according to assembly number, and are arranged in descending alpha-numerical order. The P.C. Board Assembly numbers appear on each page of the Parts List.

TABLE C-2

P.C. BOARD ASSEMBLIES

TABLE NO.	ITEM	PAGE NO.
C-4	Low Voltage Power Supply P.C. Bd. Ass'y 50D568	C-5
C-4	Vertical & Horizontal Deflection P.C. Bd. Ass'y 50D569	C-9
C-4	High Voltage Pwr Supply P.C. Bd. Ass'y 50D573	C-12
C-4	Interconnect Bd. Ass'y 50C1370	C-5

C4.0 PARTS LIST (TABLE C-4)

C4.1 Table C-4 contains a list of parts in alpha-numerical order and under the particular board number (See Table C-2) the following information is given:

a. Title, board number and unit identification.
b. Schematic control.
c. Part number
d. Description.

C4.2 Schematic unit symbols (resistors, capacitors and etc.) are printed on the four P.C. Board Assemblies for easier identification and location purposes.

Description of component parts given in Table C-4 are as complete as possilbe to help assist in procurring the part other than Sperry Division. However, many parts are manufactured only by Sperry Division and therefore are available at Sperry. Contact the Automation Industries, Inc., Sperry Division, Danbury, Conn., U.S.A., Sales/Service Office.

C5.0 For parts identification other than P.C. Board Assembly, additional parts breakdown list will be included in Tables C-5 through C-7).

C5.1 This will include parts breakdown drawing and parts list. The following information for each item is given:

a. Item number
b. Schematic Symbol
c. Part number
d. Description

C5.2 Table C-3 contains a list according to assembly number.

TABLE C-3

ASSEMBLY PARTS BREAKDOWN

TABLE NO.	TITLE	PAGE NO.
C-5	Transformer Chassis Ass'y 50C1355	C-15
C-6	High Voltage and Plug-in Bd. Ass'y 50C1372	C-16
C-7	Rear Panel and L.V. Pwr Supply Ass'y 50E615	C-18

TABLE C-4

PARTS BREAKDOWN LIST

Interconnect Board Assembly 50C1370

Schematic Symbol	Part Number	Description
C101	196D157X0015GB	Capacitor 150uf 15V Sprague
C104	Same as C101	
C102	5HK P10	Capacitor .1uf 500V Sprague
C103	same as C102	
C106	same as C102	
C105	TG-P10	Capacitor .1uf 100V Sprague
J101	26-4200-24S	Receptacle Amphenol
J103	26-4401-24S	Receptacle Amphenol

Low Voltage Power Supply P. C. Board Assembly 50D568

Schmatic Symbol	Part Number	Description
C201	BR60-450	Capacitor 60MF 450V C.D.E.
C202	TVA1608	Capacitor 20MF 350V Sprague
C203	5GA-D10	Capacitor .001MF 1KV Sprague
C204	TT350X2	Capacitor 2MF 350VMallory
C205	39D107F250HL4	Capacitor 100MF 250V Sprague
C206	TE1509	Capacitor 20MF 150V Sprague
C207	Same as C203	
C208	TE1501	Capacitor 2MF 150V Sprague
C209	TVA1512	Capacitor 50MF 250V Sprague
C210	Same as C206	
C211	Same as C203	
C212	Same as C208	
C213	BR50-150	Capacitor 50MF 150V C.D.E.
C214	TE1409	Capacitor 20MF 100V Sprague
C215	TE1401	Capacitor 2MF 100V Sprague
C216	39D408G025JS4	Capacitor 4000MF 25V Sprague
C217	TE1164	Capacitor 200MF 15V Sprague
C218	TE1135	Capacitor 100MF 12V Sprague
C219	TE1163	Capacitor 150MF 15V Sprague
C220	Same as C216	

(Continued)

TABLE C-4

PARTS BREAKDOWN LIST (Cont'd)

Low Voltage Power Supply P.C. Board Assembly 50D568

Schematic Symbol	Part Number	Description
C221	Same as C217	
C222	Same as C218	
C223	Same as C219	
CR201	CER72	Diode
CR202	Same as CR201	
CR203	Same as CR201	
CR204	Same as CR201	
CR205	VR47A	Diode Sarkes Tarzian
CR206	Same as CR205	
CR207	VR56A	Diode Sarkes Tarzian
CRc08	Same as CR207	
CR209	Same as CR207	
CR210	Same as CR201	
CR211	Same as CR201	
CR212	Same as CR201	
CR213	Same as CR201	
CR214	VR22A	Diode Sarkes Tarzian
CR215	Same as CR205	
CR216	Same as CR205	
CR217	Same as CR201	
CR218	Same as CR201	
CR219	Same as CR201	
CR220	Same as CR201	
CR221	Same as CR214	
CR222	Same as CR207	
CR223	Same as CR201	
CR224	Same as CR201	
CR225	Same as CR201	
CR226	Same as CR201	
CR227	1N4751A	Diode
CR228	3A50	Diode Solitron
CR229	Same as CR228	
CR230	Same as CR228	
CR231	Same as CR228	

(Continued)

TABLE C-4

PARTS BREAKDOWN LIST (Cont'd)

Low Voltage Power Supply P.C. Board Assembly 50D568

Schematic Symbol	Part Number	Description
F201	361.500	Fuse 250V ½Amp Type 8AG Littlefuse
F202	Same as F201	
F203	361.250	Fuse 250V ¼Amp Type 8AG Littlefuse
F204	Same as F203	
F205	361002	Fuse 250V 2Amp Type 8AG Littlefuse
F206	Same as F205	
Q201	MJ423	Transistor with MTG Kit & Insulator Motorola
Q202	MST30SP	Transistor M.S. Trans. Co.
Q203	DIS410	Transistor with MTG Kit & Insulator Delco
Q204	Same as Q202	
Q205	Same as Q203	
Q206	Same as Q202	
Q207	Same as Q203	
Q208	2N5190	Transistor with Lockwashers & Insulator Motorola
Q209	2N3642	Transistor Fairchild
Q210		
Q211	2N3638	Transistor Fairchild
Q212	Same as Q211	
Q213	Same as Q209	
Q214	Same as Q211	
Q215	Same as Q211	
Q216	Same as Q211	
Q217	2N5193	Transistor with Lockwashers & Insulator Motorola
R201	-	Resistor 20K 2W ±5%
R202	-	Resistor 9.1K 1/2W ±5%
R203	-	Resistor 2K 1/2W ±5%
R204	SV-1031	Potentiometer 10K A.B.
R205	-	Resistor 150K 1W ±5%
R206	-	Resistor 15K 1W ±5%
R207	-	Resistor 13K 1/2W ±5%
R208	-	Resistor 10K 1/2W ±5%
R209	Same as R204	
R210	-	Resistor 62K 1/2W ±5%

(Continued)

Low Voltage Power Supply P.C. Board Assembly 50D568

Schematic Symbol	Part Number	Description
R221	-	Resistor 51K 1/2W 5%
R222	Same as R217	
R223	Same as R218	
R224	Same as R221	
R225	Same as R220	
R226	Same as R217	
R227	-	Resistor 160K 2W ±5%
R228	-	Resistor 39K 2W ±5%
R229	-	Resistor 36K 1W ±5%
R230	Same as R206	
R231	Same as R208	
R232	Same as R208	
R233	-	Resistor 1K 1/2W ±5%
	PA1-1B	Heatsink I.E.R.C.
	2215-B	Heatsink Thermalloy
	MPT6003	Socket Transistor Ind. Elect.
S101	50B1741	Switch, Illuminated - DS101

Deflection Amp. P.C. Board Assembly 50D569

Schematic Symbol	Part Number	Description
C401	TG-D50	Capacitor .005uf 100V Sprague
C402	5GA-S20	Capacitor .02uf 1KV Sprague
C403	5GA-T30	Capacitor 300pf 1KV Sprague
C404	TG-S20	Capacitor .02uf 100V Sprague
C405	TE-1135	Capacitor 100uf 12V Sprague
C406	Same as C404	
C407	Same as C402	
C408	196D104x0035DB	Capacitor 1uf 35V Sprague
C409	196D106x0020FB	Capacitor 10uf 20V Sprague
C410	Same as C417	
C411	5GA-Q10	Capacitor 10pf 1KV Sprague
C413	Same as C405	
C414	Same as C404	
C415	TG-S50	Capacitor .05uf 100V Sprague
C416	5GA-D10	Capacitor .001uf 1KV Sprague
C417	5GA-T10	Capacitor 100pf 1KV Sprague
CR401	1N914	Diode
CR402	Same as CR401	
CR403	Same as CR401	
CR404	Same as CR401	
L401	9230-32	Choke 3.3mh J.W. Miller
L402	Same as L401	
Q401	2N3906	Transistor Motorola
Q402	40423	Transistor R.C.A.
Q403	Same as Q402	
Q404	Same as Q401	
Q405	2N698	Transistor Texas Instruments
Q406	2N3563	Transistor Fairchild
Q407	2N3904	Transistor Motorola
Q408	Same as Q401	
Q409	2N3118	Transistor R.C.A.
Q410	2N3119	Transistor R.C.A.

(Continued)

Deflection Amp. P.C. Board Assembly 50D569

Schematic Symbol	Part Number	Description
R401	-	Resistor 1/2W ±5% 100 ohms
R402	SV-2021	Potentiometer 2K ±10% Allen Bradley
R403	SV-1031	Potentiometer 10K ±10% Allen Bradley
R404	Same as R401	
R405	-	Resistor 1/2W ±5% 5.1K
R406	Same as R405	
R407	-	Resistor 1/2W ±5% 2K
R408	Same as R401	
R409	Same as R401	
R410	-	Resistor 1/2W ±5% 82 ohms
R411	SV-5021	Potentiometer 5K ±10% Allen Bradley
R412	Same as R407	
R413	-	Resistor 1/2W ±5% 43K
R414	-	Resistor 1/2W ±5% 560 ohms
R415	Same as R414	
R416	-	Resistor 1/2W ±5% 1K
R417	-	Resistor 1/2W ±5% 680 ohms
R418	Same as R401	
R419	-	Resistor 1/2W ±5% 10 ohms
R420	Same as R407	
R421	Same as R401	
R422	-	Resistor 1/2W ±5% 12K
R423	NS10	Resistor 10W ±3% 640 ohms Dale
R424	Same as R419	
R425	Same as R423	
R426	Same as R419	
R427	-	Resistor 1/2W ±5% 56 ohms
R428	Same as R427	
R429	Same as R419	
R430	Same as R419	
R431	Same as R427	
R432	Same as R419	
R433	Same as R422	
R434	Same as R419	
R435	Same as R419	

Deflection Amp P.C. Board Assembly 50D569

Schematic Symbol	Part Number	Description
R436	-	Resistor 1/2W ±5% 5.1K
R437	Same as R416	
R438	-	Resistor 1/2W ±5% 1.8K
R439	Same as R416	
R440	Same as R401	
R441	Same as R407	
R442	Same as R436	
R443	SV-2511	Potentiometer 250 ohms ±10% Allen Bradley
R444	Same as R427	
R445	Same as R427	
R446	Same as R456	
R447	Same as R407	
R448	-	Resistor 1/2W ±5% 51 ohms
R449	Same as R416	
R450	Same as R411	
R451	Same as R416	
R452	-	Resistor 1/2W ±5% 10K
R453	Same as R436	
R455	Same as R401	
R456	-	Resistor 1/2W ±5% 510 ohms
R457	Same as R407	
R458	-	Resistor 1/2W ±5% 330 ohms
R459	-	Resistor 1/2W ±5% 820 ohms
	50B1697	Heatsink
	MPT-4003	Socket-Transistor I.E.H.C.
	MPT-6003	Socket-Transistor Ind. Elec. Hdwr. Co.
	2215B	Heatsink Thermalloy
L101	50B1742	Coil-Trace Alignment

TABLE C-4 PARTS BREAKDOWN LIST (Cont'd)

High Voltage P.C. Board Assembly 50D573

Schematic Symbol	Part Number	Description
C301	30GA-S10	Capacitor .01mf 3KV Sprague
C302	60GA-T50	Capacitor 500pf 6KV Sprague
C303	Same as C302	
C304	TT350X2	Capacitor 2uf 350V Mallory
C305	T-360C686M015AS	Capacitor 68uf 15V Kemet
C306	DD30-102	Capacitor .001uf 3KV Centralab
C309	Same as C306	
C310	196D157X0004FB	Capacitor 150uf 4V Sprague
C311	196D157X0015GB	Capacitor 150uf 15V Sprague
C312	Same as C311	
C313	DD30-202	Capacitor .002uf 3KV Centralab
C314	Same as C301	
C315	Same as C301	
C316	Same as C301	
C317	Same as C301	
C318	5GA-T22	Capacitor 220pf 1KV Sprague
C319	Same as C310	
CR301	B223-50	Diode Edal
CR302	Same as CR301	
CR303	Same as CR301	
CR304	VR10A	Diode Sarkes Tarizian
CR305	1N914	Diode I.T.T.
CR306	Same as CR305	
Q301	2N5193	Transistor with Lockwashers & Insulator Motorola
Q302	Same as Q301	
Q303	MST200SG	Transistor M.S. Trans. Corp.
Q304	50A4355	Transistor Modification
Q305	2N3820	Transistor Texas Inst.

High Voltage P.C. Board Assembly 50D573 - Cont'd

Schematic Symbol	Part Number	Description
Q306	Same as Q301	
Q307	2N3906	Transistor Motorola
R301	-	Resistor 1/4W ±5% 10 ohms
R302	Same as R301	
R303	-	Resistor ±5% 1K
R304	-	Resistor 1/2W ±5% 100K
R305	Same as R304	
R307	NS5	Resistor 5W ±3% 3.9K Dale
R308	-	Resistor 1/4W ±5% 10K
R309	-	Resistor 1/2W ±5% 360 ohms
R310	-	Resistor 1/2W ±5% 10 ohms
R311	-	Resistor 1/4W ±5% 3K
R312	50A4359-1	Potentiometer 250K Allen Bradley
R312	-	Resistor 1/2W ±5% 150K
R314	-	Resistor 1/2W ±5% 150 ohms
R315	Same as R304	
R317	50A4358-1	Potentiometer 1M Allen-Bradley
R318	-	Resistor 2W ±5% 2.7M
R319	-	Resistor 1/2W ±5% 470K
R320	-	Resistor 1/2W ±5% 1M
R322	-	Resistor 2W ±5% 2.2M
R323	SH1051	Potentiometer 1M Allen Bradley
R324	Same as R312	
R325	-	Resistor 1/2W ±5% 1.5M
R328	Same as R308	
R329	Same as R311	
R330	-	Resistor 1/2W ±5% 200K
R331	-	Resistor 1/2W ±5% 2.2M
R332	50A4007	Potentiometer 2.5M Allen Bradley
T301	50B1740	Transformer High Voltage

TABLE C-4 PARTS BREAKDOWN LIST (Cont'd)

High Voltage P.C. Board Assembly 50D573 - Cont'd

Schematic Symbol	Part Number	Description
VR301	Z84R2	Neon Glow Lamps Signalite
VR302	Same as VR301	
VR303	Same as VR301	
VR304	Same as VR301	
VR305	Same as VR301	
VR306	Same as VR301	
VR307	Same as VR301	
VR308	GV3A-1800	Corotron 1800V Victoreen
VR309	Same as VR308	
	MPT4003	Trans. Socket Ind. Elect. Hdwr. Co.
	MPT6003	Trans. Socket, Ind. Elect. Hdwr. Co.
	PAI-1B	Heatsink I.E.R.C.
	A018	Knob Slotted J. Millen Co.

TABLE C-5

PARTS BREAKDOWN LIST

Transformer Chassis Assy 50C1355 (See figure C-1)

Schematic Symbol	Part Number	Description
T101	50C1300	Transformer-for the UM771 Reflectoscope
T101	50C1367	Transformer-for the UM775 Reflectoscope

(Connectors are supplied with Transformer)

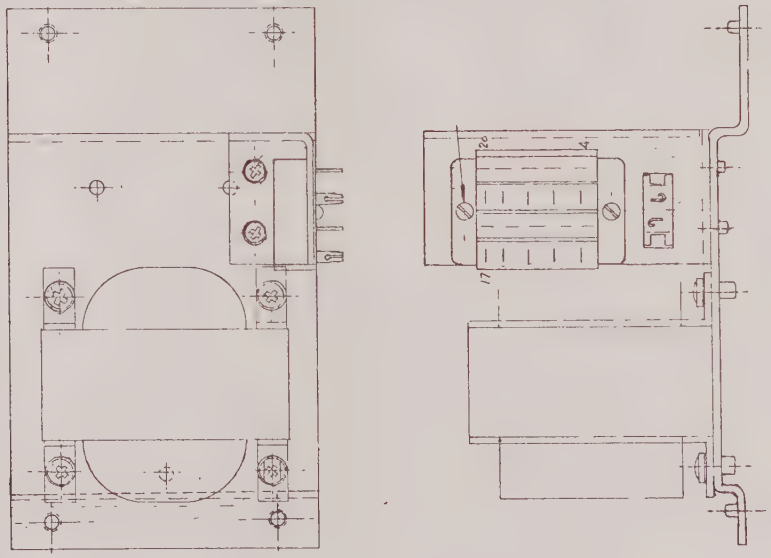


Figure C-1 Transformer Chassis (T101)

TABLE C-6

PARTS BREAKDOWN LIST

High Voltage And Plug-In Board Assembly 50C1372 (See Figure C 2)

Item No.	Schematic Symbol	Part Number	Description
1	P110	60-6501-3218	Connector
2	-	60-6501-0312	Contact Elco
3		50C1339	Plug-in P.C. Board
4	-	-	Screw #6-32x1/2 Lg. Philips Bind Hd. SST
5	-	-	Nut Hex #6-32 Small Pat. SST
6	-	-	Lockwasher #6 Int. Tooth SST
7	-	143-44-12-028	Socket Cinch Jones
8	-	242-18"	Anode Connector National Teltronic
9	-	50D573	High Voltage P.C. Board Assembly
10	-	50C1371	Harness H.V. Board to CRT & Intero. Board
11	-	-	-
12	-	-	-
13	-	-	-
14	-	42718-2	Terminal Amp
15	-	Fit-105 3/32	Black Tubing Heat Shrinkable Alpha
16	-	1920	Wire High Voltage 5KV
	V101	50B1652	CRT

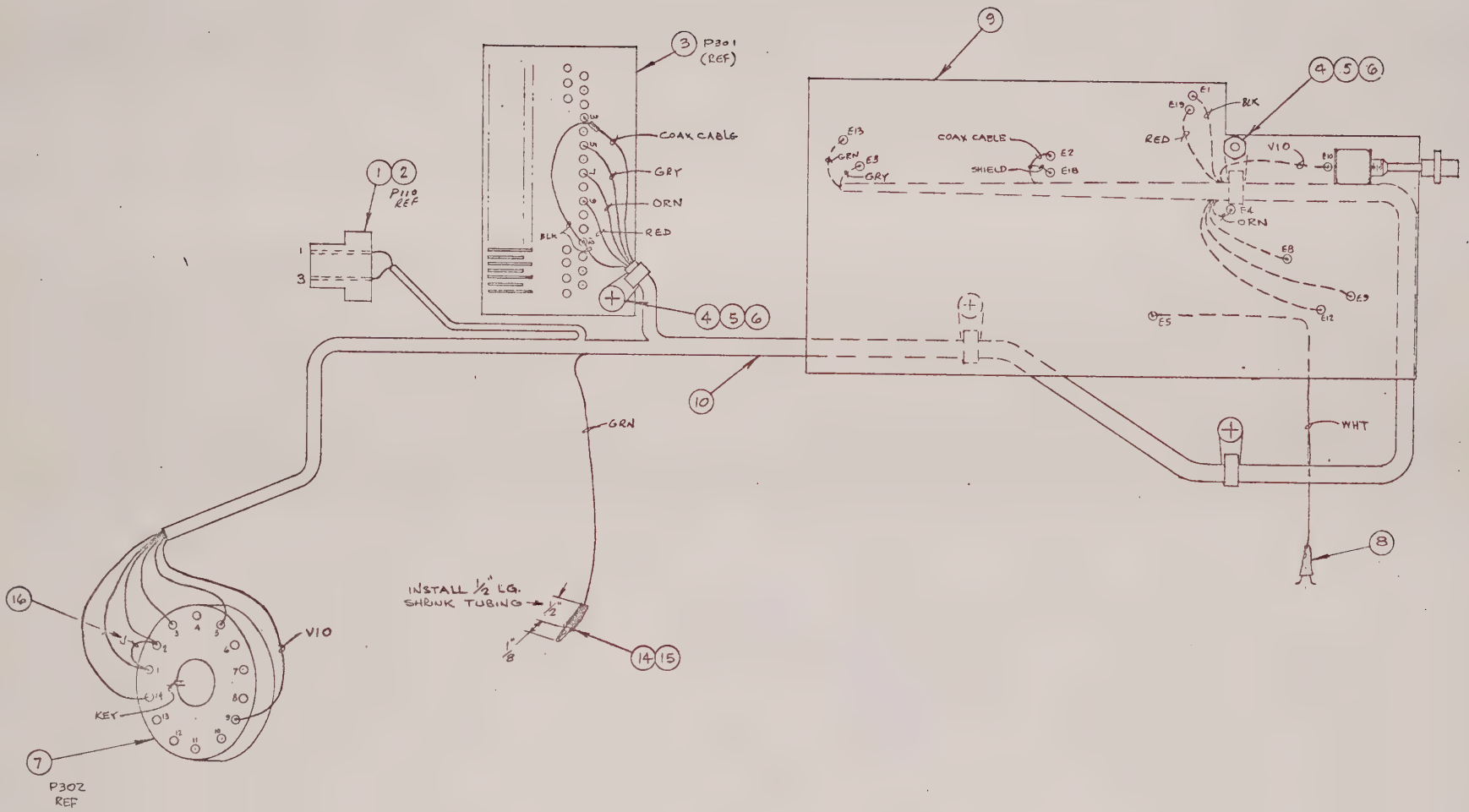


Figure C-2 High Voltage And Plug-In Board Assembly 50C1372

TABLE C-7

PARTS BREAKDOWN LIST

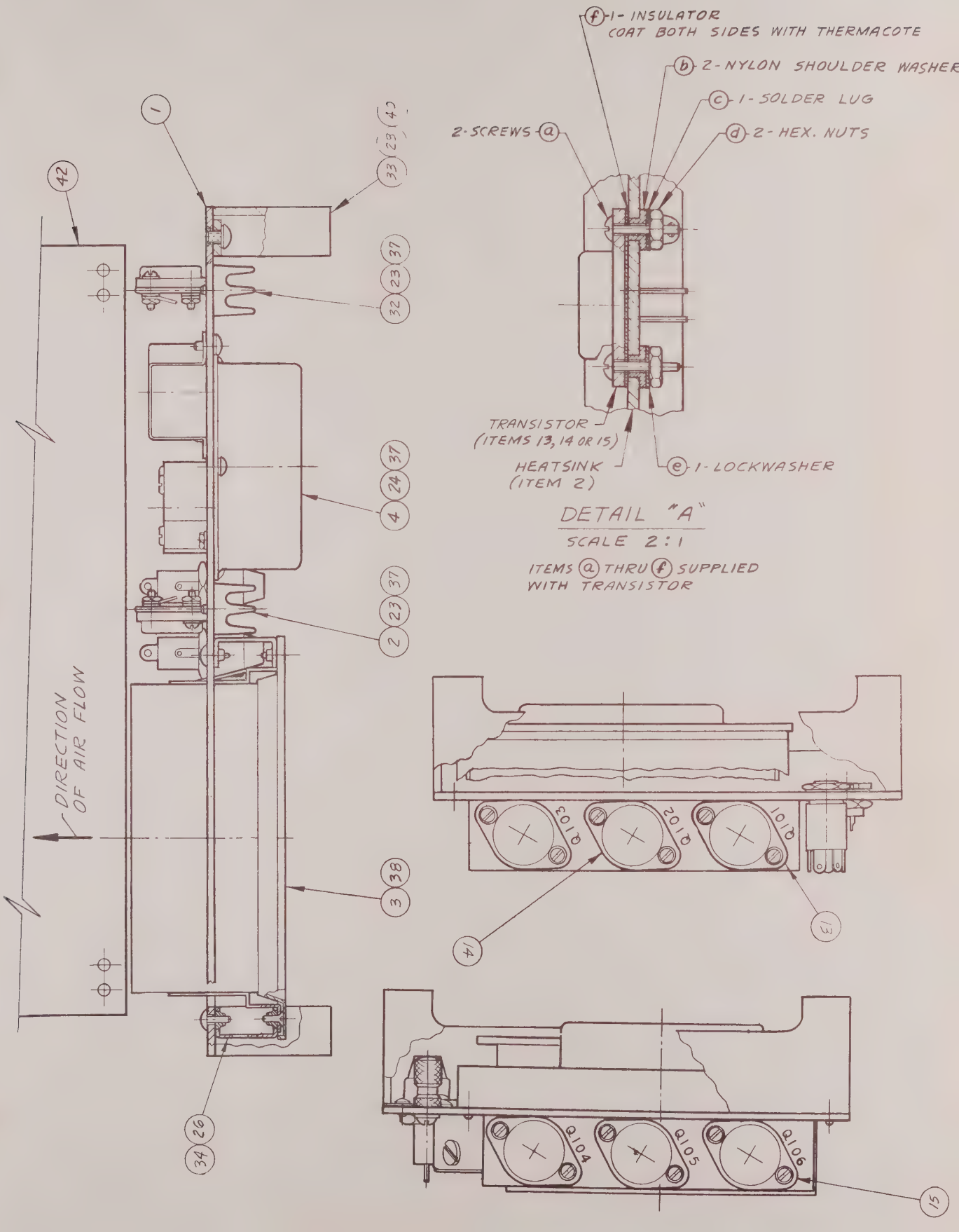
Rear Panel And L.V. Power Supply Assembly 50E615 UM771/775 Reflectoscope (See Figure C-3)

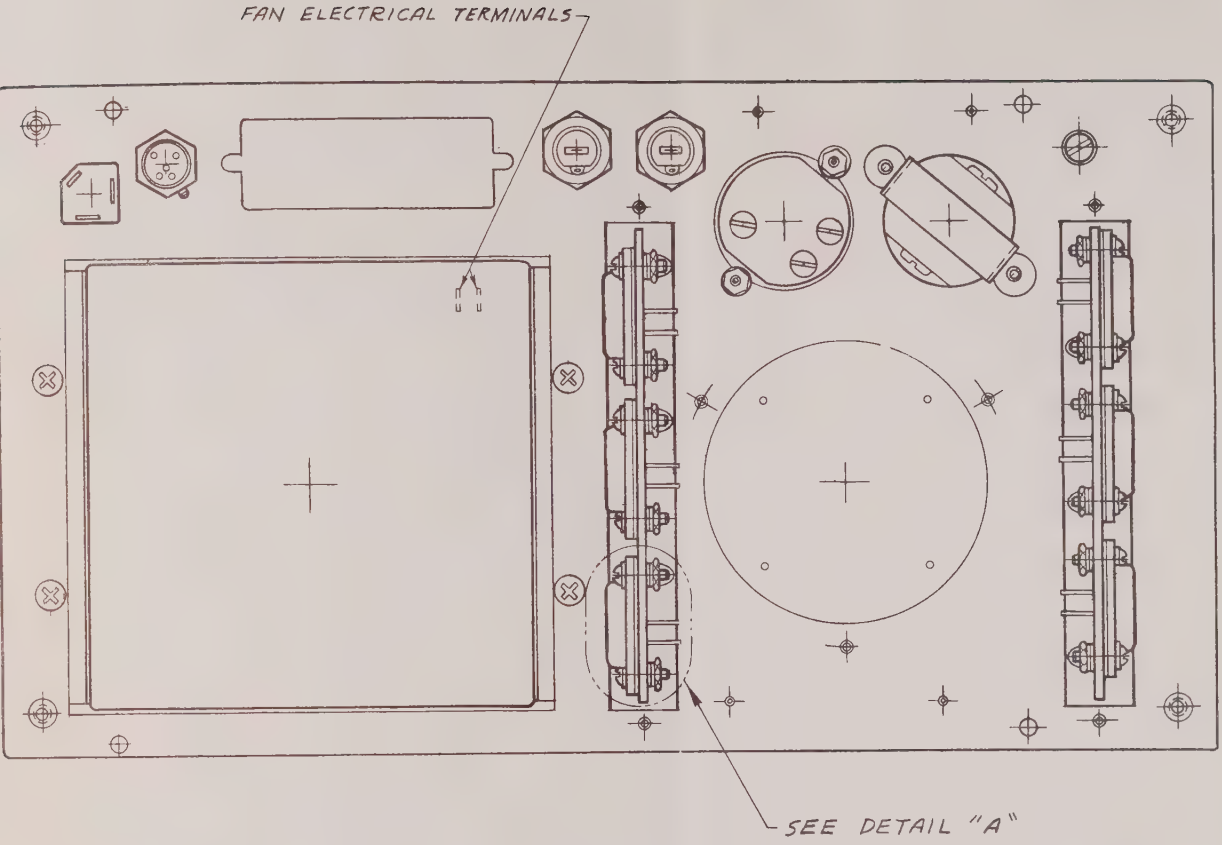
Item No.	Schematic Symbol	Part Number	Description
1	-	50D556	Rear Panel
2	-	50C1345-1	Heat Sink
3	B101	Mark 4	Filter Fan Rotron M745 Motor
4	-	50B1727	End Cover
5	J105	126-218	Socket Amphenol
6	-	-	-
7	F101	3AG	Fuse 5A 125V Slo-Blo Littlefuse
	F102	Same as F101	
8	-	342-12	Fuse Extractor Post 3AG Littlefuse
9	C101	DD3-103	Capacitor 2x.01uf 600V Centralab
10	J107	GE4390-1	Receptacle G.E.
11	J108	5258	Receptacle Hubbell
12	-	110	Binding Post H.H. Smith
13	Q101	MJ423	Transistor with MTG Kit Insulator Motorola
14	Q102 thru Q105	DTS410	Transistor with MTG Kit Insulator Delco
15	Q106	DTG2400	Transistor with MTG Kit Insulator Delco
16	-	00A131	Nameplate
17	-	-	-
18	-	-	-
19	-	RA2217-170M	Lug #6 T & B
20	-	-	-
21	J109	112 B	Phone Jack Switchcraft
22	-	-	Screw #2x3/16 Type B PHH Truss SST
23	-	-	Screw 4-40x3/8 PHH Truss SST
24	-	-	Screw 4-40x1/4 PHH Truss SST
25	-	RA2247-170M	Lug #8 T & B

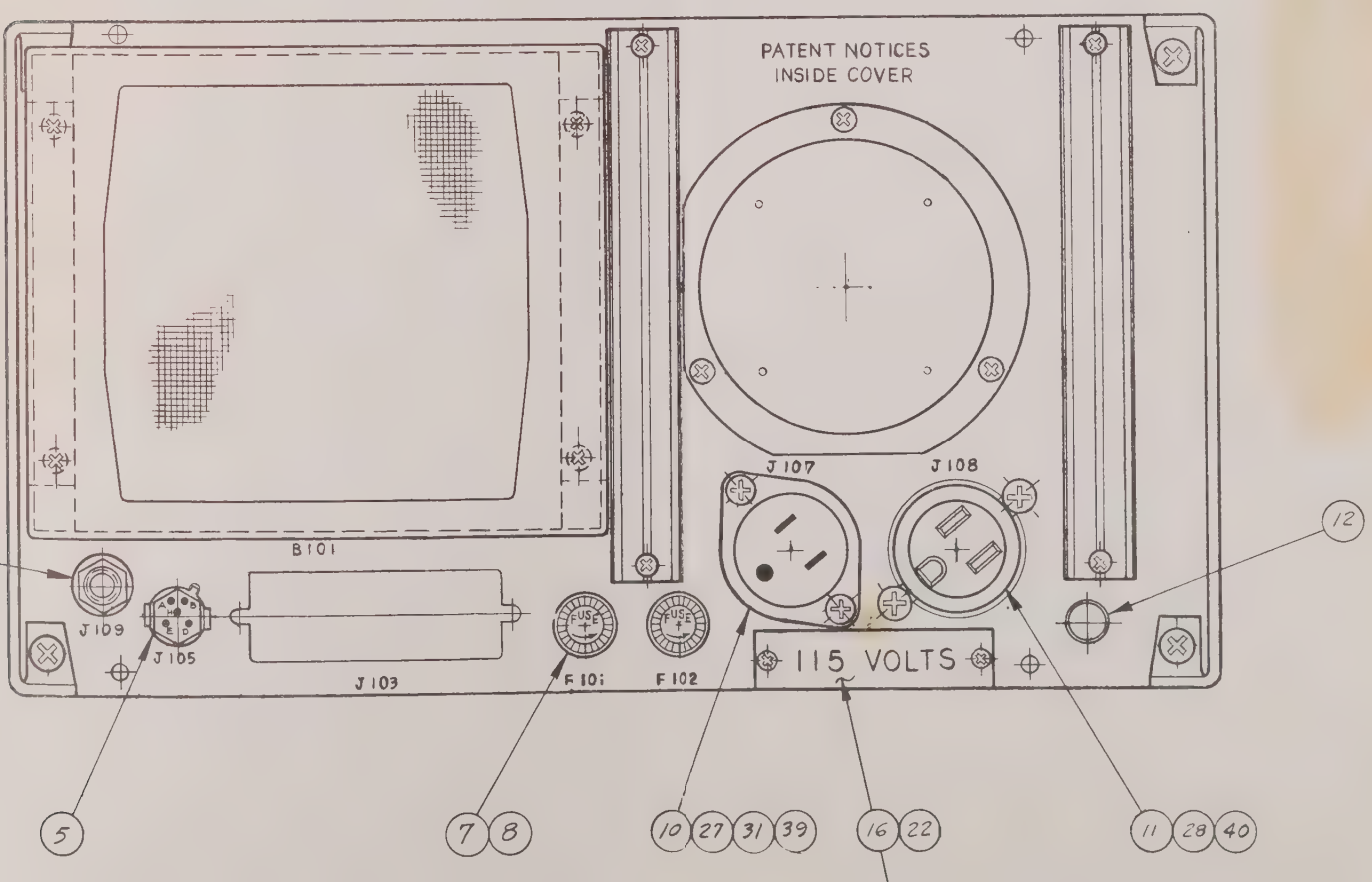
TABLE C-7 . PARTS BREAKDOWN LIST (Cont'd)

Rear Panel And L.V. Power Supply Assembly 50E615 UM-771/775 Reflectoscope
(See Figure C-3)

Item No.	Schematic Symbol	Part Number	Description
26	-	-	Screw 6-32x3/8 PHH Truss SST
27	-	-	Screw 6-32x3/8 PHH Truss SST
28	-	-	Screw 8-32x5/16 PHH Truss SST
29	-	-	-
30	-	-	-
31	-	-	Hex. Nut #6-32 Small Patt. SST
32	-	50C1345-2	Heat Sink
33	-	50C1340	Rear Leg
34	-	50B1722	Fan Bracket
35	-	-	-
36	-	-	-
37	-	-	Lockwasher #4 Intl. Tooth SST
38	-	-	Screw 6-32x3/8 PHH Flat SST
39	-	-	Lockwasher #6 Intl. Tooth SST
40	-	-	Lockwasher #6 Intl. Tooth SST
41	-	-	-
42	-	50C1368	L.V. Board & Harness Assembly
43	-	50C1369	Wiring Diagram
44	-	50E618	Schematic
45	-	3075	Wire #18 Awg STC Wht Alpha
46	-	3075	Wire #18 Awg BRN Alpha
47	-	3075	Wire #18 Awg STR BLK Alpha
48	-	3071	Wire #22 Awg BRN Alpha


ⓕ 1 - INSULATOR
COAT BOTH SIDES WITH THERMACOTE
ⓑ 2 - NYLON SHOULDER WASHER
ⓒ 1 - SOLDER LUG
ⓓ 2 - HEX. NUTS
2 - SCREWS ⓐ
TRANSISTOR
(ITEMS 13, 14 OR 15)
HEATSINK
(ITEM 2)
ⓔ 1 - LOCKWASHER
DETAIL "A"
SCALE 2:1
ITEMS ⓐ THRU ⓕ SUPPLIED
WITH TRANSISTOR
DIRECTION
OF AIR FLOW
Q103
Q102
Q101
Q104
Q105
Q106
1
2
3
4
13
14
15
26
32
33
34
37
38
42


FAN ELECTRICAL TERMINALS
SEE DETAIL "A"


PATENT NOTICES
INSIDE COVER
J 107
J 108
B 101
J 109
J 105
J 103
F 101
F 102
115 VOLTS
12
5
7
8
10
27
31
39
16
22
11
28
40
115 V. STANDARD

APPENDIX D

SCHEMATIC

D1.0 INTRODUCTION

This section contains a fold out Schematic 50E618 for the UM771/775 Reflectoscope CRT Display. This section is supplied to supplement the in formation presented in the Text.

D.1. The schematic is laid out to show the overall circuit function of the UM771/775 Reflectoscope CRT Display. The schematic provides technical information about the electrical value and identification of the capacitors, fuses, resistors, transistors, transformers, diodes, lights, plugs and fuses. Input and output (AC-DC) voltages are shown on the schematic. These measuring points are shown as "E" numbers on the P. C. Boards. Signals such as unblanking RF etc., also are tied in to the "E" numbers on the P. C. Board. All four P. C. Boards (voltages and signals) tie in together through an Interconnection P. C. Board Assembly 50C1370. See Table D-1 for Schematic Symbols identification.

D1.2 A heavy dotted line around a particular circuit indicates a Printed Board Assembly. There are four of these heavy dotted line P.C. Board Assemblies as shown on the Schematic. Certain number series also are associated with the components on the P.C. Board Assemblies.

a. Low Voltage Power Supply P.C. Board Assembly 50D568.

b. High Voltage Power Supply and Unblanking P.C. Board Assembly 50D573.

c. Deflection Amplifier P.C. Board Assembly 50D569.

d. Interconnection P.C. Board Assembly 50C1370.

The Pulser/Receiver, Timer and Accessory Plug-in units are not shown on this schematic. Signals and voltages from these units are tied in through the Reflectoscope Display Plugs.

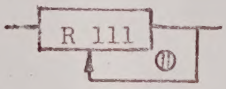
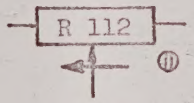
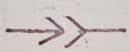
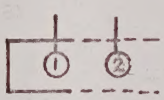
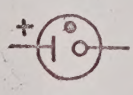
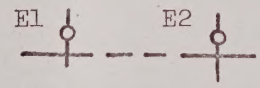
a. J101 - Pulser/Receiver

b. J402 - Timer

C. J106 and J102 - Accessory

D1.3 J105 and J109 are located in back of the UM-771/775 Reflectoscope and are used to operate a mounted Reflectoscope Camera.

TABLE D-1

SCHEMATIC SYMBOLS IDENTIFICATION		
	=	Field effect transistor
	=	Screwdriver, Adjustable Resistor
	=	Screwdriver, Adjustable potentiometer
	=	Single Pin connector
	=	Multi-pin connector
	=	Gas filled Referenced Diode
	=	"E" Number Connections on P.C. Bd.

BEAVERITE
BEAVER FALLS, N.Y.
MADE IN U.S.A.

9C5-370

00C040